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ABSTRACT

Thus far, there is little statistical evidence to show that new technologies have had an appreciable impact on the amount of learning that takes place in schools throughout the country. In order to find some of the causes of this lack and to point out policy questions in this area, the author surveys several issues in the field of new information media. He discusses the impact of the new technologies on the universities, and he likens the development of cable television to the founding of the postal service. He examines some of the issues in publishing, noting the lessons to be learned from the development of the publishing industry and tracing the effects of new technologies on the industry. In dealing with the library crisis, he notes that the access to adequate storage and distribution techniques of both print and non-print media will have to be improved if libraries are to thrive. Personal contributions to the "social memory", he notes, are more limited by the new technologies than they were by the advent of pencil and paper. The copyright problems arising from facsimile transmission, dry copying techniques, and cable television are examined in some detail. (JY)

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INSTITUTE ON TELECOMMUNICATIONS AND PUBLIC POLICY

WILL INFORMATION TECHNOLOGIES HELP LEARNING?

- An Analysis of Some Policy Issues -

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I. INTRODUCTION

How to meet the varied learning needs of people of all ages is among those burning questions of public policy where, in the past two decades, faith in advanced technology as an answer peaked, then receded. The questions remain and so does the potential of technology.

The high expectations of the 60's are typified by Adam Yarmolinsky's criterion for turning an idea into a working program. The idea had to meet "a deeply felt - even if inadequately perceived - national need" and the proposed program was to "produce visible results within a limited period of time" (1.1). By 1971, however, Patrick Moynihan admitted to having learned that "things are far more complicated than we had thought. The rather simple input-output relations which -- naively no doubt, but honestly -- we had assumed to obtain in education simply, on examination, do not hold up. They are not there" (1.2).

There is growing realization that it is hard to perceive learning needs adequately, hard to assess the value of technology for learning and hard to deploy people, processes and tools effectively. At the same time, the pace of decision-making that will shape the patterns of learning for decades to come is quickening: decisions critical for learning are being shaped in the entertainment and telecommunications industries and, to a lesser extent, in the computer industry and traditional educational circles. The government agencies most directly responsible for these decisions are not those charged with concern for learning. Without widespread public knowledge and debate, the issues are being shaped and settled by narrow and disparate interests.

A specific aim of this paper is to clarify both the impact of information technologies on learning and the forces behind this impact, so that informed citizens might participate more fully in guiding a coherent evolution of the nation's strategic resources for learning.

A general aim is to suggest that how information technologies will affect learning has much in common with how these technologies will affect other services, such as the delivery of health care, that share the following characteristics analyzed in the sequel:

1. Many diverse established and new technologies, with different traditions and institutions, find themselves competing in unfamiliar and ill-defined arenas.

2. Each of the competing technologies can meet, in principle, many competing social objectives. Systems best suited for one objective are not necessarily effective or economical for another.

3. Measurable characterizations of objectives fail to encompass the whole of our intuitive conceptions of these objectives. There is much disagreement about the conceptions themselves.

4. Objectives present themselves as needs and not as market demands. Demand cannot be assured without a supply to meet it, yet the costs and risks of investing in supplying an uncertain demand are high.

5. The transition from hot-house demonstration to stable self-sustaining operation in the field entails a substantial rise in the scale of activity of each of several interlocking spheres. None of these spheres can sustain itself without the others.

6. The spheres of activity straddle the public and private sectors in ways for which neither the defense or space markets nor the consumer products markets are useful precedents.

7. To what end and by whom the supply of services is controlled is of vital public interest.

Because of the irreducible intertwining of technologies, objectives and spheres of activity, our attempts at neat separations for purposes of discussion have resulted only in changes of emphasis among the various sections of the paper, with common themes cutting across all.

The idea that technology might help learning admirably fits Yarmolinsky's criterion for a quacky quickie. It meets a national need that is perceived very inadequately indeed. A precise and generally acceptable description of the number and types of learners does not exist. In 1968, 58 million people were in formal schools from kindergarten through college (1.3). 64 million are expected by 1978 (1.4). Schooling, namely what happens in schools, colleges and universities, represents at least 6 or 7 percent of the American economy (1.5). What part of the American population spends what part of its time and resources learning in other formal ways is less precisely known. Stanley Moses estimates the number of adults learning in formal organizational, proprietary, anti-poverty, correspondence, TV and other adult programs -- which he calls the "educational periphery" -- at 44 million in 1965, 60 million in 1970 and 82 million in 1975 (1.6). Finally, Fritz Machlup estimated in 1962 that a very broadly defined "knowledge industry" accounted for a 29 percent share of the American economy in 1958 (1.7).

There is now great concern over how inefficiently learning needs are being met. Higher education's costs per student have been increasing at 5-7% a year for many years (1.8). Meanwhile, productivity, as output per man-hour, has shuffled upward at 1.9% a year for all services, education included. Only the Post Office's pace of 0.23% is slower. At the other extreme, output per man-hour in the communications industries has grown at an average 6.2% a year in the same 1956-1966 period (1.9).

Yet, not so long ago, in the immediate post-Sputnik era, potential Soviet technological supremacy was seen as more threatening than numbers and costs; science curriculum was then a fashionable concern. Many social critics, who see schooling as inhumane or ineffective, especially for those disadvantaged by economic status, race, sex or age, stress "individualization" of learning. At the extreme, Ivan Illich would deschool society altogether. College students have criticized impersonality and concentration on cognitive aspects of learning at the expense of various other needs of the developing individual, but current economic pressures are spurring student interest in acquiring marketable knowledge and skills.

How can technology best help people to learn as their own goals change along with social and economic conditions? The question is worth asking only if granted that technology can serve learning at all. This is by no means evident from the kind of research done to date. Far from producing "visible results within a limited period of time", educational technology, even when it embodies new concepts from learning theory or exploits new tools, has made no significant difference in measurements of the learning achieved through formal schooling.

C. R. Carpenter and L. P. Greenhill found this in an early (1958) study of closed circuit television in university courses. As they put it, "controlled experiments which compare direct and televised instruction with the same teachers teaching the comparison groups are unlikely to yield statistically significant differences in students achievement scores when the courses, teachers, and students are similar to those in the ... experiments"(1.10). Twelve years later, in 1970, Philip D. Smith, Jr., found no significant difference after comparing "traditional" methods of language learning with variants of the "audio-lingual" or "functional skills" approach (1.11). The literature on computer-aided instruction abounds with similar findings. As for programmed instruction, Paul Saettler, in his History of Instructional Technology, after noting that "more than three quarters of all of the research on programmed instruction has been undertaken since 1960", asserted that "the general conclusion from all this research was that no significant difference was found among treatment comparisons and, when significant differences were obtained, they seldom agreed with other findings on the same problem" (1.12). As for the contributions to practice of scientific learning studies

> "it has been found enormously difficult to apply laboratory-derived principles of learning to the improvement of efficiency in tasks with clear and relatively simple objectives. We may infer that it will be even more difficult to apply laboratory-derived principles of learning to the improvement of efficient learning in tasks with more complex objectives" (1.13).

Indeed, after reexamining the Coleman Report with several colleagues, Moynihan tells us how "no one involved in Coleman's analysis took any pleasure in finding how very little educational effect could be traced to traditional measures of school quality such as pupil-teacher ratios or levels of educational expenditure. That is the way the work came out" (1.14).

Were it not that no-significant-difference findings fly in the face of common sense and other myths, one might dismiss technology as irrelevant to learning. But who can deny the impact of printing technology on learning? It is so much taken for granted and so pervasive in our society that it sometimes escapes conscious attention. Saettler, for example, says hardly anything about it. That learning also happens through "non-instructional" broadcast television is equally obvious but, being no one's business, this effect is still dimly understood. Goodwin Chu and Wilbur Schramm, in Learning from Television, bypass it, saying that "a great deal of learning from non-instructional television undoubtedly occurs, but that is another story and another monograph" (1.15). Joseph Klapper's The Effects of Mass Communication discusses crime and violence in the media and how adult TV fare affects child audiences, but excludes "the use of mass media in formal pedagogy", because "consideration of the problems peculiar to that field and of the already vast literature would clearly require a separate study, of direction, length, and complexity at least equal to the one here reported" (1.16).

No-significant-difference findings confirm the fact that research on schooling is inadequate. They do not belittle the impact of technology on learning. The differences sought are generally differences in performance on tests of a subject's capacity to reproduce accurately information supplied by a teacher or teaching instrument in a formal school setting. For example, the extensive film research program carried out by C. R. Carpenter and his associates for the Navy and the Army between 1947 and 1955 measured performance through multiple choice questions incorporating a unique "correct response" (1.17). A very limited aspect of learning under very limited conditions is therefore being measured.

The Pennsylvania Foreign Language Project, which tested nine facets of behavior from listening comprehension to pupil expectations and attitudes attempted to measure a wider range of performance. The validity of the available measuring instruments was seriously questioned by both the investigators themselves (1.18) and their critics (1.19). Reliable formal research on instruction is restricted to very limited aspects of what both common sense and learning theory see learning as encompassing.

Significant differences are often found, with varying degrees of objectivity and reliability, in outcomes or correlates of learning other than those measured by formal achievement tests, such as student or teacher attitudes, costs of instruction, stability of schools, pace of learning, etc. Differences of achievement have also ensued from varying factors other than conventional classroom inputs, as Moynihan points out in reporting that the Coleman Report did produce "strong evidence of the educational benefits of mixing poor with non-poor children, and of mixing races" (1.20).

The absence of significant differences has a very significant positive implication, namely that learning as now measured is largely independent of the details of means, hence that issues of technology and policy on the one hand and of learning method and content on the other must be resolved on other grounds. *No-significant-difference findings therefore leave wide open alternatives to the accepted ways of schooling, alternatives that might, according to public preference, reduce costs, increase individualization or offer some other dominating personal or social benefit without, at the very least, making any difference so far as measurable learning performance is concerned.* These benefits are neither all equally attractive to everyone nor unequivocally measurable. Preferences and priorities keep changing. Acceptable strategies for making technology responsive to learning needs must therefore permit continuing and diverse public choices; decisions about both ends and means must be reserved as matters of public policy and not left unattended to experts. The strategic question of how technology affects control over the means of learning must take precedence over pedagogical nits to assure that public preferences - or significant differences, if some are ever found - will be accommodated by technology and not dictated by how it is deployed.

Learning must be conceived broadly, encompassing not only schooling but also learning outside formal schooling institutions. This is too large a subject to be discussed here without leaving something out. For example, we will not consider the impact of technology on the management of learning; air conditioning does affect the use of educational plant and computers help with business affairs in education as in other enterprises, but such important matters are regretfully left out.

In this essay, we emphasize aspects of learning based on symbolic information, hence on technologies serving as vehicles for linguistic or pictorial symbols. The world itself, the people in it, and their symbolic records together embody the social memory which is the foundation of learning. Our scope is restricted to those artifacts and institutions dealing with "information transfer", namely those which embody and articulate the symbolic portion of the social memory; but by "learning", we mean partaking of all social memory, a continuing act of which information transfer and formal higher education are but limited aspects.

II. LEARNING AND THE MEDIA OF SOCIAL MEMORY

Man and nature are obviously the basis for learning, but a child isolated from people or deprived of artifacts could, within his lifetime, gain but very little of the knowledge about himself and the world eked out by countless generations. So, the transmission of knowledge by example and by word remains an important function of mothers, families, colleagues and elders, agents whose importance to learning keeps getting rediscovered.

Artifacts significant for social memory include objects which, like buildings, paintings or bicycles, are in themselves relics of the past or realities of the present to be learned about or mastered. They also include objects which like books, computers or television gear, serve learning primarily as vehicles for symbols. This distinction between real objects and vehicles for symbols corresponds roughly to the distinction between learning by doing and book learning. To emphasize vehicles for symbols is to neglect many opportunities for more effectively exploiting real objects in learning (2.1), although surrogates are essential to express abstract ideas and to communicate about things distant in space or time. In themselves or as symbolic vehicles. whethe objects of the present or images of the past, artifacts collectively embody the storage function of the social memory.

Dead storage is not a useful social memory. People need access in order to contribute to and draw from memory. Stability and continuity of storage are essential if the record of the past is not to be lost nor to become unintelligible too soon. But the storage mechanism must also be flexible enough to adapt to the evolution of knowledge, to changes in our perception of the relative importance of records. It must be able to grow and accommodate new information, and able to forget and spare the cost of storing unwanted information. This implies selection mechanisms to decide what should be stored and also to enable the learner to find what he wants in the store.

Whatever the store's form, it can be useful only with means for access or distribution, namely ways to bring the learner to the store or the store to the learner. Although apparent autodidacts, like Abraham Lincoln and Andrew Carnegie, are reputed to have taught themselves, some learning is assisted by family, peers, superiors, counselors or teachers -- natural or automatic -- who serve as mediators between the learner and the store. Formal schooling is the current institutionalization of one mediation pattern, as bound apprenticeship was in an earlier era. Finally, every society embodies explicit or implicit control mechanisms for selecting learners and for managing storage and related accessing, distributing, selecting and mediating functions.

Throughout history technology has presented us with alternative media for performing these various essential functions of social memory. Details of the impact of the invention of writing are lost to us in prehistory. The introduction of moveable type into the West in the 15th century and the subsequent development, between the 18th and 19th centuries, of printing from continuous reels of paper, of producing paper by machine and of the rotary press established, in some societies, the primacy of the printed medium of social memory over the earlier mixture of manuscript and oral tradition (2.2). The telegraph in 1835 and the telephone in 1876 enormously speeded up the carriage of word and sound over vast distances. The invention of the phonograph in 1877 and its elaborations through electronic technology supplied artifacts for storing sound. Still photography in 1822, followed by moving pictures first in film and then in videotape, made storing pictures easier than did older technologies like painting and engraving. In this century, broadcast radio, followed by broadcast and, more recently, cable television, brought new ways of distributing voice and pictures far and wide. Since the 1950's, computers have opened new possibilities not only for storing information but also for selecting, mediating and controlling and, together with telecommunications, for distributing.

Figure 1 briefly characterizes competing technologies detailed in the remainder of this essay. Principal functional capabilities are listed across the top and media serving these functions along the side. How well a capability is currently embodied in a medium is very coarsely shown as primary or secondary. "Primary" denotes the engineering of a medium with the effective and efficient performance of the associated function as a major goal. "Secondary" functions are poorly embodied owing partly to intrinsic limitations but mainly to past emphasis on primary functions at the expense of the secondary.

All of the technologies listed in Figure 1 are interchangeable in the limited sense that any one of them can handle any information the others can. In principle, the combination of computers and telecommunications can literally do everything all the others can. In current practice it is easier to record a speech on tape than to print it in those cryptic phonetic symbols. Something is always lost in translation from a picture to a thousand words and vice-versa. The style of a medium communicates

CAPABILITY OF

MEDIA	REPRESENTING				Manipulating Discrete Representations (e.g,calculating)	Storing Representations	Transmitting Representations	Controlling own and other operations
	Audible Speech	Discrete Symbolic Speech (e.g, Morse Code)	Still Pictures	Moving Pictures				
Computers	Secondary	Primary	Secondary	Secondary	Primary	Primary	Secondary	Primary
Common Carrier Switched Telecommunications (e.g.,the telephone system)	Primary	Secondary	Secondary	Secondary	Secondary	Secondary	Primary	Secondary
Movie Film	Secondary	Secondary	Secondary	Primary		Primary		
Videotape	Primary	Secondary	Secondary	Primary		Primary		
Audiotape	Primary					Primary		
Live Broadcast TV	Primary	Secondary	Secondary	Primary			Primary	
Live Cable TV	Primary	Secondary	Secondary	Primary			Primary	
Live Broadcast Radio	Primary						Primary	
Moveable Type on Paper		Primary	Secondary			Primary		

Figure 1: Functional Capabilities of Current Technologies

enough to confuse Marshall McLuhan into claiming that the medium literally is the message. But most information can survive passage from one medium to another -- often with difficulty or loss of quality -- as from the book to the movie. Moreover, almost anything can be said in any one medium witness the range of subject headings in the catalog of any large library.

Consequently, the content of learning does not necessarily swing the choice between media. Given no-significant-difference, neither do the present fruits of learning research. Nor, finally, does it matter much what the dispensing institution is: basically, a book's a book, whether bought in the store, borrowed from the library or lent by the school. To understand whether and how technology can help learning we must search for really dominating factors. As we shall see, the dominating factors are the need to balance preference for economy against preference for individual choice and related issues of control over the media of learning. In this context education, as a fragmented market, is only a short tail firmly wagged by an enormous mongrel.

Computers and telecommunications aside, the remaining media listed in Figure 1 divide into two groups: moveable type and all the others. Differing legal, commercial and professional traditions distinguish these two groups from each other and from computers and telecommunications. The moveable-type-on-paper industry grew out of scholarly tradition and the religious market. Although newspapers, magazines and the like eventually struck out on distinct paths, the book industry still retains formal schooling as its primary and most profitable market. Computers and telecommunications were shaped by commercial, industrial and military markets. All the others evolved in the traditions of the entertainment market. We shall see that difference in traditions is a key to understanding the impact of the various technologies on learning.

Because technology now permits increasing interchangeability, in practice and not only in theory, these diverse industries, hitherto in minimal competition with one another, find themselves in common markets. Their competition is characterized by a high degree of confusion and mutual incomprehension ensuing from their earlier isolation and their differing traditions. Torn between the desire to protect their traditional markets and the desire to move into hitherto inaccessible markets, they also scramble with their competitors for newly opening markets.

Wherever the primary and secondary capabilities of the various technologies complement one another, the old media tend to be harnessed together. New hybrids develop as technology and visions of unexploited markets encourage shifting the relative balance among primary and secondary capabilities toward increased competitive potential. Some of the potential competitors are controlled or protected by regulation, some are under the eye of the Justice Department and all are dependent on the outcome of bitter and protracted debate over Congressional revision of the Copyright Act. Who shall have access to services, who shall be in control, what will be the costs of services to learners and by whom they will be borne; these are major policy issues deserving of resolution guided by a broad and informed public. The most likely governing factor will be market power, guided perhaps by public opinion and government policies.

The dominating interactions between the market place and learning strategies depend on a set of factors sketched earlier in Run, Computer, Run (2.3) and now conveniently grouped under the rubric "scale of aggregation". The meaning of this rubric is clearest with respect to devices used in learning, such as books or computers, where scale of aggregation simply covers the familiar range from custom-building to mass production. But goals of learning may likewise range in aggregation from particular goals, such as a personal urge to learn all about the history of one's birthplace, to universal goals, such as literacy for everyone in a nation. Processes of teaching may entail varieties of custom tailoring, as in adjusting the next assignment to the prior achievement of each pupil in a class or, at the other end of the aggregation scale, setting the same assignment for all pupils. The individual learner may obviously be exposed to learning alone or lumped with other individuals in a group. All of these scales of aggregation have in common the relations among technology, costs and degree of aggregation illustrated in Figures 2a-c.

Figure 2a illustrates the basic notion that for a given technology unit costs generally go down as the degree of aggregation goes up. Each one of 100,000 cars coming off a Detroit production line costs less than if it were the only one of its kind ever built. The cost to an individual of tracing and learning all about the history of his birthplace is greater than what it costs each of many individuals to learn from common sources about the history of their nation. A teacher spends far more time writing out a different assignment for each pupil in a class than putting one assignment on the blackboard for all to see. Delivering a lecture to 500 students in a hall obviously costs less per student than delivering it to each in turn.

One fundamental question we shall face repeatedly further on is how to get from a low degree of aggregation with high unit costs to a high degree of aggregation with low unit costs or, in brief, how to get from high cost prototype or custom production to the economies of scale. This question must be faced whatever the motives for transition including, potentially, the desire to turn some significant experimental difference into a significant practical difference in learning.

With any new technology or new product, there is no way of knowing for sure that there really is a market willing to buy, even at low unit cost, enough units to recover investment in tooling up for mass production and distribution. The fate of Ford's Edsel is one example of a wrong guess by minds experienced with a relatively stable technology and a familiar market.

Since demand may not even be visible without prior commitment to an attractively low unit cost and since committment to a low unit cost entails at least faith if not certainty in high enough demand, the path from here to there contains a vicious circle. Classically, in our economy, the circle is broken by the entrepreneur whose hopes of profit outweigh his fears of loss. As we shall see, the effective deployment of new technology for learning typically entails many interlocking circles which private entrepreneurs are unwilling or unable to break.

Strategic choices between lowering costs and lowering aggregation arise from the interchangeability of the technologies presented in Figure 1. Why one would prefer lower costs over higher needs no explanation.

Preference for low aggregation over high is a fundamental consequence of preference for meeting varied and changing demands of diverse individuals over locking everyone in step. Since no-significant-difference findings leave the way open not only for variety, but also for faddish ecstasy over some innovation treated as obviously significant until adequately tested, not letting any one innovation take over can also help save some lemmings from running into the sea. That educators have perverted "individualization" into a self-serving and empty slogan should not blind us to these fundamentals.

The following illustrations show that trade offs between costs and aggregation are not foreclosed by inexorable technological imperatives but that it is also illusory to expect, as is still common, that new technology will necessarily make everybody happy by lowering costs and aggregation simultaneously. Figure 2b illustrates one possible relationship between the cost curves for an established technology (Technology A) and a new competing technology (Technology B). For a given established technology status, illustrated by point X in Figure 2b, new options are illustrated by points Y, Z and C. In case Y, lesser aggregation is realizable at the established technology cost. Alternatively, as illustrated by point Z, the established technology degree of aggregation can cost less. A compromise between advocates of lower costs and advocates of lower aggregation is illustrated by point C, where neither cost nor aggregation is as low as the new technology permits, but both are nevertheless lower than the established technology permits. The magic of technology is often invoked to disguise the fact that the exact location of compromise point C is fixed not by technological demons but by interplays of people and institutions.

The particular relationship between curves A and B in Figure 2b supports the illusion that new technology necessarily lowers both costs and aggregation. However, compromise may be impossible if, instead, circumstances are as illustrated in Figure 2c. In case I, moving from point X to any point on either curve left of the crossover point O implies lower aggregation at necessarily higher cost. In case II, moving from point X to any point on either curve right of the crossover point O implies lower cost at necessarily higher aggregation. In both cases, the decision to move is rationally justifiable only on grounds of policy preference for lower aggregation, in the first case, or for lower cost, in the second case. Given a decision to move, switching to the new technology B is rational in either case, since costs are lower on curve B than on curve A after either move. If, however, the switch to a new technology is made first, based only on faith and promises without attention to the distinction between Figure 2b and 2c and between the two cases in the latter, a rude awakening may jolt those whose policy choice has thereby been preempted.

Both cases are logically reasonable on the basis of very gross judgments about the specific technologies illustrated. But both cases are merely very hypothetical illustrations, since drawing actual curves requires sound data, consummate skill, great resources and deep faith. Moreover, actual curves, when they exist, convey the very essence of competitive plans. They are therefore jealously guarded secrets. The critical relevant observation, in Figure 2c as in Figure 2b, is that policy choice is not dictated by technology, but might easily be abdicated.

The choice between the distinct degrees of aggregation for processes in case I and case II arises only granted that the devices used in either case are or can be mass-produced. Otherwise, the curves B would be shifted sharply upward and flattened, and the issue would not present itself seriously at all just as, if there were no post-office, the choice between favoring first-class, print or junk mail would not arise. The levels of aggregation for devices, goals, processes and learners are mutually related, but not wholly determined by one another, as illustrated by the choice between cases I and II created by the possibility of mass-producing devices.

Our emphasis throughout this essay is on aspects of the technology of devices and systems which, if determined blindly, might preempt later strategic choices about goals, content and method of learning. Choosing among different learning strategies, varying the degrees of aggregation and balancing judgments of benefits against costs are therefore broad issues of social policy not to be left primarily to special groups. Policy guiding technological developments must particularly assure enough flexibility in setting degrees of aggregation to accommodate the diverse and changing preferences of our society for balance between low aggregation and low cost.

Technology, economics and preferences about degrees of aggregation have distinguishable and relatively independent impacts on the various steps leading from personal contributions to social memory through distributing, storing and accessing, to personal drawings from the memory. For example, the writer of a book might reflect his personal idiosyncrasies, express universal goals of a prescribed curriculum or reflect the official views of a ruling party. Publication and distribution may be highly personal and informal as in the Soviet "samizdat" or the limited circulation of lecture notes or else be mass production as of thousands of printed copies, widely promoted and sold. A person may buy a copy to store on his own shelf and multiple copies may be stored in many libraries. Finally, a book may be assigned or read aloud to a large captive audience or else selected by a person and read privately in whole or in part as he sees fit. The choices at every step all reflect some balance between aggregation and cost.

We shall therefore examine the relative impacts of the technologies and the traditions described in Figure 1 on selected steps from contributing to social memory to drawing from it. We shall see, at each step, that balancing preference for low degrees of aggregation to meet the varied and changing demands of diverse individuals with preference for low costs through economies of scale raises critical policy issues about control over the means of learning. How to make the transition from perceived needs unmatched by firm demand to an effective market capable of supporting economies of scale on a stable continuing basis will present itself as a recurring question.

At each step, certain of the interlocking vicious circles blocking transitions will be more visible than others. Bringing all these circles into full view and mapping the details of their interlocks is an essential task for the future, to which we contribute only a beginning. We perceive that the dynamic characteristics of these interlocks partake of the complexity and the counterintuitive behavior that Jay Forrester has discerned in other social systems. Deeper historical and analytical understanding of this aspect of the interactions between technology and society is clearly necessary. We hope, however, that the light we manage to shed will help private citizens and corporate and public officials make their decisions now with greater regard for implications beyond accepted narrow spheres of action than has been customary and possible. It is essential that the strategic means for learning be free of self-serving control to assure flexible response to learning preferences and freedom of access to information for all.

III. TECHNOLOGY AND EVOLUTION OF THE UNIVERSITIES

Whatever its embodiments, social memory is useful to a learner only if he can go to the store or else have the store brought to him. The creation and growth of community colleges over the last decade reflects one kind of judgment about the value of bringing learners to the store with its associated mediators and, as implied by the deployment of these institutions primarily in urban centers, about the costs of transportation and housing.

Several new institutions have recently undertaken what they perceive as the "most urgent task" of providing for learning by many people "fully capable of a higher education who, for one reason or another, do not get it" (3.1). Different programs designed to meet differing demands among this constituency all assume that the constituency is unable or unwilling to attend classes on a particular campus at a particular time: the store must therefore be brought to the learner wherever he is and whenever he can use it. This stark reversal of conventional educational patterns has forced planners of new institutions to greater attention to the subject of this essay than has been necessary where discomfort is felt within the reassurring shells of conventional educational institutions, which are merely pricing themselves out of the market, even when engaged in mass production.

From the learner's point of view programs now operating or being planned fall into three categories:

1. those which bring learning and degree-earning opportunities to whatever mailing address, electrical outlet, telephone, or transistorized receiver the learner chooses;

2. those which offer the community, the city or the world as a vast classroom through which guidance is offered and from which one can graduate with recognized credentials;

3. those which will test knowledge, however gained, with an examination that entitles the passer to specified credentials.

The first category includes programs ranging from the familiar correspondence course - long a standard medium in many areas without alternatives, such as the Australian outback, to the Open University which began serving learners in Great Britain in January 1971. The Open University is a fully accredited institution aiming to reach the "great unused reservoir of human talent and potential" which the "existing system, for all its expansion, misses and leaves aside". It offers people, mainly fully-employed adults of every social and economic background who "are willing to commit themselves to the hard work involved" (3.2), a chance to obtain a Bachelor of Arts degree through courses offered via the facilities of the British post office and of the British Broadcasting Corporation. The media used include correspondence as the principal operating medium, supported by television, radio, face-to-face tutorials and computers for administration and testing.

How many students the University admits is limited by the subsidies it receives from the British government. Tuition, at £45 ($115) per course, falls in a range bounded by U. S. state and private universities. As in these institutions, tuition does not cover costs. Nor is the number of students large enough yet to make even the marginal cost of additional students low enough to be covered by tuition. Open University plans for raising more money include marketing its own software and hardware -- texts, study guides, films, videotapes and laboratory equipment -- to the general public (13).

The feasibility of the venture owes substantially to the Open University's grafting on the facilities of the post office and the BBC thereby bypassing many of the problems of going from nothing to a viable scale.

The Open University-BBC liaison is not surprising. Unlike U.S. commercial television, the BBC has a substantial history of catering to the learning needs of its public and it is respectfully regarded in academic circles. In this country, television learning ventures requiring large amounts of capital, such as Sesame Street, have been significantly financed by private foundations and produced with the facilities of non-commercial networks. Where such arrangements cannot be made, as in the case of several new U.S. "open" universities, television options remain closed.

Open University planners do not have to worry too much about no-significant-difference findings. The mainstay of the curriculum is the printed correspondence course. Television is supplementary, albeit substantially so: 1/3 of the budget goes for TV. In fact, faculty concern that courses should compare favorably with similar courses taught at top British universities pressures the Open University to keep in line with conservative academic traditions. One key advantage of the television medium -- and of the BBC liaison in particular -- is its capacity to advertise the University. Over 40,000 applicants applied for admission to the first year of operation. Of the 25,000 who were accepted, 20,000 enrolled; 5,000 more were then accepted and enrolled. Of these, 19,000 remained by fall of 1971. Projected enrollments of this scale enabled the Open University to contract for enough microscopes of a novel design to induce the manufacturer to redesign the stainless steel industrial model selling near £150 into a sturdy plastic model sold near £15, with a share of the revenues accruing to the University. The investment in new TV Programming is producing fresh and promising results.

The British Open University is the largest going program of its type to date, but others of similar intent are being planned. One, for instance, envisioned by a small private, for-profit organization in Connecticut will use existing telephone company and post office facilities to communicate with its students, "busy adults, carrying a full share of adult responsibilities" (3.4). Printed and laboratory materials, audio cassettes and the telephone will cary information to the learner at home or wherever he wishes to be. This same organization now has a more limited program offering, through the same media, courses which prepare the learner for passing specific examinations in the College Level Examination Program (CLEP) of the College Board. A learner can take courses simply because he is interested or because he wishes to get college-level credit for working on his own. Over 500 colleges and universities around the United States award credit toward a degree on the basis of performance on the CLEP examinations. Thus, the existence of CLEP encourages private companies to enter the education market and bring "accredited" information to the learner wherever he may be.

In New York State, a proposed Empire State College will provide courses for a degree to be acquired through programs combining the first category of home study based on educational films, cassettes and correspondence with the second category of off-campus work-study experiences and periods of study elsewhere in America or abroad. Administrators do not foresee liaison of the Open University-BBC type with any broadcasting station (3.5); broadcast television and radio are therefore too expensive to figure in the curriculum plans of the college. More likely will be the use of audio and video cassettes to be borrowed from and -- in the case of video, played at -- the nearest of the seventy-odd libraries on the campuses of the State University of New York, a plan which deflects the program from its store-to-learner goal. The belief that this form of learning will prove far cheaper than in the standard institutions, remains to be sustained by practice.

The Empire State College combines the home-oriented type of "open university" with a community-based one. An example of an institution which falls completely in the latter category is the University Without Walls, a consortium of some nineteen Midwestern and Western Colleges, each setting up independent facilities for programs which will allow students to do the major portion of their work in off-campus jobs, for which they will receive credit. The current plans do not include any systematic use of the television and radio media, although individual programs might use an existing televised course (3.6). While learners will pay the same tuition as in traditional schools, their cost to the institution is expected to be much less. The apparent cost saving will be rooted to some extent in costs borne by the community, and that only so long as unpaid lay "professors" are willing to cooperate by absorbing these costs.

The third way in which opportunities for post-secondary learning are being broadened is the provision of an examination for anyone who feels he has, in whatever fashion, acquired the necessary knowledge to pass it. In this way, the institutional route to credentials can be bypassed. At present, New York State is planning to have comprehensive examinations for the granting of an Associate in Arts as well as a Bachelor of Business Administration degree. The idea is also being considered on a wider scale: at a recent meeting, Jack N. Arbolino, Executive Director of the Council on College Level Examinations of the College Entrance Examination Board, proposed a 'national university' that would grant degrees to anyone in the nation who passed its degree examinations (3.7). The nature of control over the evaluation criteria for such a far-reaching examination is a vital public policy issue.

The alternatives currently being considered in the "open university" movement raise further important issues:

1. The foregoing alternatives cater to adults who have "the self-discipline necessary for this kind of highly independent study" (3.8). How many people really fall into that category? In the Australian outback, isolation is a way of life. It isn't in New York City or in London -- can people be isolated learners in that environment? How many people who really would like a higher education have this kind of self-discipline?

Perhaps "openness" applies only to a rather narrow range of people, "housewives and business men and others who already have had some college" (3.9). Would two-way or multiple telecommunications help motivate and meet the perceived needs of many people who never entered higher education? The answer to this question depends on the extent to which telecommunications can indeed complement or replace face-to-face interactions and on whether the process can be economically attractive. We address the latter question within our analysis of the factors governing choices of alternative media for learning.

2. Claims of cost savings are impressive, but so far unsupported by hard data. One characteristic and recurrent difficulty is bootstrapping from an experimental stage where need is inadequately perceived. and unit costs are high to full fledged demand by enough people to bring unit costs down to a level where self-sustaining operations are possible. In many cases, incremental costing and shared costs obscure accounting and make generalization to different circumstances difficult. At what point, for example, would the British Open University prove less expensive than the traditional system were it not grafted on the facilities of the BBC? What is the significance of spreading learning costs through a community used as a learning medium? Will the predicted costs of easily identifiable items (cassette production, for example) prove accurate? What would be the cost of stocking libraries if, for instance, many people chose the third alternative of completely independent study? These questions of bootstrapping and shared use of facilities primarily serving purposes other than schooling are examined in detail later on.

3. To date very little attention has been paid to the problems of distributing, producing, using and updating material for programs using the newer technology. We address ourselves to such questions throughout the following analysis, and particularly in Sections VII and VIII.

IV. PUBLIC ACCESS TO DISTRIBUTION: POSTAL SERVICE AND CATV

The growing interest in "open universities" reflects concern about wider access to higher education and, insofar as plans for these universities call for using correspondence or television, a shift in balance between bringing the learner to the store and the store to the learner. Transportation and telecommunications are key elements in this particular balance, and of strategic importance in determining the patterns of information flow and learning throughout our society.

Railroads, trucks and airplanes are the instruments whereby the post office, freight forwarders and other distribution agents transport letters and carry books, films or videotapes from manufacturer to warehouse and to the learner, directly or through dealers, schools or libraries. The learner comes to the store with transportation powered by everything from muscles to jets. Telecommunications offers an alternative to physical transportation of people or symbolic vehicles. To date, broadcast radio and television are the most significant means of bringing the store to the learner through electrical telecommunications. Except for occasional question-answering services, telephone lectures or the teaching of handicapped children at home, the telephone has had little direct impact on formal learning. Cable television is still in its infancy.

New telecommunications technology, of which cable television is a prime example, potentially combines broadcast television's ability to transmit huge amounts of information with the selectivity and two-way communication capability of common carrier switched telecommunications. Ten to one-hundred fold cost reductions over present telecommunications costs are anticipated (4.1). How much these anticipations are realized, hence their effect on ventures such as open universities, depends on the balance struck among broadcasting, selective distribution and two-way capabilities. Realization depends also on the efficiency with which facilities are operated and shared, and on the mix of telecommunications technologies, from wire pairs to satellites to microwave to laser beams. Most significantly, it depends on how public policy guides investment and sets patterns of access to information conduits and of control over the information transmitted.

The key issue of providing wide public access versus seeking profits only through concentration in markets clearly favorable to rapid and riskless transition to economies of scale is illustrated by the history of the postal service, still a competitor of newer media in distributing representations of both symbolic speech and pictures. Through their influence on cost patterns and the economies of scale, technological factors clearly affect but solely do not settle the rates for distribution services. Early postal rates were set neither low nor uniform, but increased with distance on the assumption that costs increased correspondingly. In 1837, a landmark study of England's post office by Sir Rowland Hill concluded that "not only was the cost for conveyance for the average of distance exceedingly small, but that it did not vary with the distance. The variation was rather in the inverse proportion to the number of letters enclosed in a mail" (4.2).

Hill's recommendation that rates therefore be independent of distance was strenuously opposed by the Post Office. After he issued his study to the public, however, "public meetings in support of it were held in all parts of the country, and numerous petitions in its favor were submitted to parliament" (4.3). Debate of Hill's ideas began in the United States in 1839 but only in 1863, and then in response to strong public agitation, was first class mail matter carried at three cents a half ounce to any distance (4.4). In both countries, public concern and action in its own behalf proved decisive.

A public interest in distribution was recognized by George Washington who, in his third annual address to the Congress, urged attention to "sufficiently liberal and comprehensive" plans for the post office and post roads, stressing their importance as an "instrumentality in diffusing a knowledge of the laws and proceedings of the government, which, while it contributes to the security of the people, serves also to guard them against the effects of misrepresentation and misconception" (4.5). Early postal legislation reflected a broader public interest in fixing low rates for newspapers and providing for the free exchange of papers among all editors and publishers" (4.6), but there was a continuing struggle between those wanting the postal service to pay its own way and those willing to have the U. S. Treasury cover deficits in exchange for meeting policy goals, notably fast overland communication with the West, broad accessibility to postal service even in remote rural areas and the advancement of education (4.7).

When, in 1968, the President's Commission on Postal Organization challenged the widespread provision of special rates for printed matter, it noted that "21% of the deficit - some 3.8% of total postal costs - represents a subsidy to such users as nonprofit institutions, mailers of educational materials and other specifically identified in the postal policy act" (4.8). The importance not only of costs but also who pays them is illustrated by the Commission's urging that subsidies such as the rural allowance be eliminated in favor of increased general revenues, on the ground that "part of the value of service to a sender of mail buying postage any place in the country is the Post Office's ability to reach practically everyone" (4.9). Aware of the sensitivity of such issues, the commission tartly pointed out that for "traditional objects of public support like educational institutions or the blind ... it might be less costly to the government and more visible to the public, if subsidies were provided directly to the subsidized organizations", but added that "valid political considerations may preclude such a method of funding" (4.10).

The postal service, like telecommunications common carriers, was created as a pure conduit of information, open to every citizen and enjoined from choosing or examining the content of transmissions. Under our system, breaches of this intent, as in Post Office suppression of pornographic mail, in wiretapping or in telephone company monitoring of conversations for quality control, are matters of intense public concern.

Book or newspaper publishing, on the other hand, combines control of the conduit or vessel, namely the physical book, with selection and control of content. Publishing is open in principle to every citizen, but the price of entry is thousands of times that of a postage stamp or a phone call. A publisher's right to unfettered selection of content is protected by the First Amendment and property privileges are granted by the Copyright Act. Broadcast television is in an intermediate position. Its ownership of conduits is not absolute, but licensed and reviewed, however blandly, by the Federal Communications Commission on grounds of public interest (4.11). Broadcasting's right of selection, while considerable, is also limited by regulation. As shown by the Congressional inquiry into CBS's "The Selling of the Pentagon" and subsequent CBS reaction, this right is not as clearly within the scope of the First Amendment as the rights of publishers. The price of entry is still higher than that of publishing and the number of broadcast channels limited by technological necessity. Even the right of access to TV at any price is in dispute. The August 3, 1971 decision by the U.S. Court of Appeals for the District of Columbia that "a flat ban on paid public issue announcements is in violation of the First Amendment, at least when other sorts of paid announcements are accepted" was therefore greeted as a landmark (4.12). On August 16 the same court produced what Variety called a gasser, "ruling that television commercials for high-powered autos and leaded gasoline present one side of a controversial issue and therefore come under the FCC's fairness doctrine" (4.13), on which equal-time practices are based.

The confluence and hybridization of these several distribution media, described in Figure 1, has stirred up clashes among their distinct patterns of choice and control. The struggle is especially bitter over cable television, where the pure conduit traditions of the postal service and common carriers and the selection and control traditions of book publishing and broadcast TV are crashing head on. The claims and rights of the multiple interests jousting in this area are barely discernible through the haze of a controversy which, in spite of its great public moment, is smoldering largely out of sight of the general public (4.14).

CATV, originally short for Community Antenna TeleVision, is nowadays commonly construed as CAble TeleVision or, with different emphasis, rebaptized BCN, for Broadband Communications Network. CATV began as a way of distributing broadcast television programs within communities otherwise physically beyond the range of tolerable broadcast signals. In this benign guise, CATV attracted little attention. It was welcomed by the broadcasters, who saw it as extending, at no expense to them, their advertising reach into markets too thin to support TV stations; and, as late as 1959, the Federal Communication Commission thought the organic Communications Act of 1934 denied it jurisdiction over CATV.

Conceptions of CATV have since evolved from tranquil bucolic visions into frenzied dreams of "wired cities", "addressed cable delivery" systems and the like, pumping entertainment, catalog shopping, learning and many other services into homes and draining opinions, purchase orders and other reactions away from them (4.15) to the vast anticipated profits of conduit and content owners. The dreams have cooled a bit under the frigid stare of cost accountants, but conduit and content owners in moving picture entertainment see the $60/year fee now commonly paid by wired households to cable operators merely as rock-bottom income from a barely tapped market. With 60 million households in 1969, this minimum income potential ranges from 2 to 4 billion dollars for 50 to 100 percent household saturation. New service opportunities and growing population both conjure up tempting prospects.

The New York State Legislature has noted "the present profitability and the large though undefined potentialities" of CATV and an intense competition for franchises leading to "allegations of speculation in such franchises to the possible detriment of the public welfare" (4.16). For example, Irving B. Kahn, then chairman and chief executive officer of Teleprompter Corporation, an ally of Howard Hughes' enterprises, has been convicted of bribery along with the mayor of Johnstown, Pennsylvania and named as co-conspirator with four officials in Trenton, New Jersey in affairs involving local franchises (4.17).

Mindful of the past fiascoes of educational radio and television (4.18), contemptuous of mass media, finding no significant difference, featherbedding or oblivious, the schooling establishment so far has done little dreaming or thinking about CATV, leaving the field to others. This despite prodding by such organizations as the Ford Foundation and, more recently, the Sloan Foundation and others, which have seen a world far wider than Instructional Television or Public Broadcasting.
By January 1971, the Secretary of Health, Education and Welfare did

inform the FCC of plans by the Office of Education to explore telecommunications needs for education (4.19). In July, 1971, Harold E. Wigren, now a consultant to the National Education Association, announced the establishment of "Publicable", a group he describes as intending to "assure all segments of the population an opportunity to become involved in the development and use of cable communication systems" (4.20). But -- mixed blessing -- educators may be too late.

Broadcasters awakened much earlier to the competitive threat of CATV. The FCC issued a series of decisions in which it claimed authority over all CATV systems through their use of microwave relay facilities. In particular, the Commission, intent on protecting the broadcast industry from competition, imposed on CATV a "freeze" on the importation of "distant signals". These are broadcast signals originating in stations outside the area served by cable and therefore competing with neighboring stations. Following a challenge in the courts by the cable operators, the Commission was upheld by the Supreme Court in a 1968 decision. That decision, however, restricted the FCC's authority to whatever was "reasonably ancillary to the effective performance of the Commission's various responsibilities for the regulation of television broadcasting" (4.21). Anyhow, Supreme Court decisions seem to settle little in this arena. WHDH-TV, a station owned by the Boston Herald-Traveler is still in its hands after 17 years of divorce proceedings and after the Supreme Court upheld, on June 14, 1971, award of the channel to Boston Broadcasters Inc. The latest FCC intervention stems from charges by the Securities and Exchange Commission against Nathan David, the executive vice president of BBI (4.22).

Within broadcast industry traditions the distant signal quarrel is intelligible as a threat of cable networks competing with the broadcasters' own networks. Common carriers have also come into this quarrel both as sources of cable facilities and as direct competitors. Independent new carriers covet network markets beyond that monopolized by the established carriers, particularly AT&T. More germane is the fact that cable suffers from fewer natural limitations than broadcasting. A single cable can carry 12, 24, 80 or more TV channels or equivalent mixtures of TV, data and voice channels. The exact number depends on investment and, in the eighty channel range, also on where the outer limits of reliable technology are believed to be. A single cable can be adapted to two-way communication or two cables may serve this purpose (4.23). The number of cables that can be strung is limited by money not by the electromagnetic spectrum. Cables can be interconnected and thus grow into telecommunications networks.

Mindful of these possibilities, numerous interests other than CATV's two natural predators, the broadcasters and the common carriers, have come into the fray. Foundations, municipalities, neighborhood associations, CATV latecomers and others have challenged CATV's broadcast tradition of control over both conduit and content, insisting on public access to channels. Indeed, some cable operators themselves have long since begun originating their own programs, mainly canned. Everyone being for the public interest, the key to CATV's future is who is willing to pay and for what and to whom.

Although estimates vary wildly in this technologically fast moving, competitive and therefore secretive realm, it is clear that costs are lowest for minimal broadcast retransmission facilities. Origination costs more than retransmission, more channels cost more than less, two-way costs more than one-way, selective transmission more than broadcast and switching capabilities more than fixed connections . Return transmission capability in two-way systems itself is a matter of varying degree and cost. Detection and recording of viewed channels to substantiate advertising rates, subscriber choice among a few discrete alternatives, voice return and full two-way pictorial capabilities illustrate the range of two-way alternatives. Technological advances shift absolute costs, as in Figure 2, but do not change the ranking.

An example will define the financial context of the struggle over how CATV is to grow. Under assumptions too detailed to recount here, John Thompson (4.24) estimates that a CATV operator must invest $125 per subscriber for a typical current 12-channel basic one-way system and $135 for a similar 24-channel system based on newer technology. To make a case for installing two-way 24-channel systems now, he estimates that upgrading a 12-channel system for limited two-way operations leads to a total cost of $285 upgrading the 24-channel system $280 and building a basic two-way 24-channel system $255. Comparable estimates are given by Barton et al and by Comanor and Mitchell. The cable operator sees mainly the gap between $125 and the higher figures. His competitors strive to shut him out of their markets by raising the bottom figure, as by encouraging municipalities to charge high royalties for franchises with a cut for public television and municipal services, while public interest pressures push on him to invest more for what he sees as a chancier market, bigger negative cash flows and longer-delayed returns on investments.

Thus, in CATV, the crucial issues of transition to economies of scale and of balance between costs and aggregation present themselves as choices concerning the origin of signals, two-way capability, public access and control over conduit and content. The foundations, citizen groups and the like minded interests press for origination, especially for the right to use conduits for their own content and therefore also for a higher number of channels. One-way communication implies mere consumption of entertainment and passive learning, and two-way communication which only allows choice among a few discrete alternatives is adequate for certain sales responses, for programmed instruction, multiple-choice testing and the like, but not for the freer exchange and broader individual choices that return voice or picture communication would allow. The commercial interest of CATV operators leads them to seek high density, high income markets for entertainment and other profitable services, while those concerned with distributing learning on a plan " sufficiently liberal and comprehensive" point to less profitable urban slums and diffuse rural areas.

In June 1970, the FCC, which had become still more deeply involved in CATV, proposed new rules under which distant signals could be imported. At the same time, however, it required cable systems with more than 3,500 subscribers to begin originating their own programs by April 1, 1971 instead of merely retransmitting broadcast television programs. In addition, the commission proposed that permanent long term financing for educational television be assisted through the assessment of a 5% annual levy on the revenues of cable systems, the proceeds to go to the Corporation for Public Broadcasting. On the one hand, this uneasy compromise would stimulate competition with broadcasting by permitting the import of distant signals. On the other hand, it would dampen competition by imposing on cable operators both greater capital costs for origination and a tax on revenues for subsidies, apparently for the public good, but also reminiscent of the youthful cutthroat competition capers of the Bell Telephone System (4.25). Cable operators understandably appealed to the courts.

The rule was suspended in May 1971, after the 8th Circuit Court of Appeals in St. Louis asserted that the FCC lacked authority to impose origination (4.26). Some CATV operators, probably sensing some competitive advantage, nonetheless continued origination (4.27). On June 15, moreover, Dean Burch, the Chairman of the Federal Communications Commission, told the Senate Commerce Committee that the FCC would appeal the Circuit Court's ruling to the Supreme Court. He announced the FCC's intention to allow all CATV systems to carry an unrestricted number of educational outlets and to propose that for each broadcast signal carried, a cable system must provide a non-broadcast channel, adding that the FCC was contemplating requiring facilities for two-way non-voice transmission to be built into every new cable system in large markets (4.28). The FCC's proposal for "near-term regulation" of cable television were spelled out in more detail on August 5, 1971 in a letter by Dean Burch to the Senate Committee. The letter stresses the FCC's concern for not "undermining the foundation of the existing over-the-air broadcast structure", including protection of conventional educational broadcasting from incursions by cable (4.29).

The proposed restriction to non-voice return transmission is a reminder that common carrier facilities are an alternative to return cable paths and, with Picturephone® (4.30), an alternative vehicle for many contemplated cable services. Indeed, common carrier status for the cables and expansion by existing common carriers into the cable field remain open policy alternatives. Responding to senatorial queries about common carrier status, the chairman of the FCC said the FCC was reluctant to regulate CATV as a common carrier because "risk capital would not be forthcoming if rate of return regulation were imposed" (4.31). Given the example of AT&T's success in raising equity capital and, indeed, its reluctance to increase debt financing (4.32), this argument has a curious ring. The real question is whether plans for CATV should be "sufficiently liberal and comprehensive" to serve the public interest in the long run. An explicit restriction did not appear in the August 5 letter, which spoke only of the usefulness of two-way transmission, "even if rudimentary in nature" (4.33).

As for common carrier expansion, the FCC in January 1970 barred telephone companies from owning CATV subsidiaries within their own service areas and ordered them not to provide CATV channel services unless the CATV interests are also given rights to run their cables over telephone company poles or through their conduits (4.34). As with the FCC's vacillating assertions of jurisdiction over CATV, this can scarcely be regarded as the last word. In July 1970, New York City awarded 20-year franchises to Teleprompter and Manhattan Cable to operate CATV systems in Manhattan, where the companies had been operating for 5 years previously. The franchise agreements call for the franchise operator to pay the city 5% of his gross receipts from television services and 10% from other possible cable services. City jurisdiction over cables has been challenged by Comtel Inc., a company leasing its cable facilities directly from the New York Telephone Company. An FCC hearing examiner upheld Comtel's right to use the facilities of the telephone utility and, as might be expected, the telephone company asserted that it had a right, as a common carrier, to accommodate any new customer.

As of October 13, 1970, new cable construction in New York City had been halted by order of the FCC, while the dispute continued among Teleprompter, Manhattan Cable and the Justice Department on one side, and New York Telephone Company and Comtel on the other. The Comtel argument has been sustained by the New York Court of Appeals but the Justice Department argues that the city has franchising authority and has asked the FCC to reconsider. On October 8, 1971, the FCC denied approval to the phone company for new construction needed for Comtel. The battle may be expected to continue (4.35). Whether the public interest in learning is better served by independent cable services controlling both conduit and content, by independent cable services operating as common carriers, or by extensions of existing common-carriers is a key public issue deserving of wide debate in broad daylight.

Common carrier status for CATV has great appeal as a policy that might in principle afford maximum public access to cable facilities, maximum divorce between control of the conduit and control of the content, and therefore potentially maximum flexibility in the choice of services to flow over the conduits. Whatever the medium, the common carrier principle affords maximum individual latitude in the choice of goals, content and method of learning. How service rates are set in practice, may, however, restrict this latitude. Moreover, the difficulty of financing the great investments needed to make cable as accessible o every citizen as the post office or the telephone is cited in support of private investment and control of both conduit and content in a cable system independent, for antitrust reasons, of the existing common carrier system dominated by AT&T.

The complexity of telecommunications issues has been widely noted. Robert W. Sarnoff recently said that "As presently framed, the Communications Act cannot possibly provide the [Federal Communications] Commission with the regulatory guidance needed for the most complex and fast-changing technology ever known" (4.36). Clay T. Whitehead, director of the White House's Office of Telecommunications Policy spoke of the development of cable as "the most important single policy issue on the communication front - perhaps one of the most significant domestic issues of this decade" (4.37). On June 23, 1971, the President set up a committee, chaired by Whitehead, to develop policy proposals for CATV. The membership reflects the breadth of affected interests: the Secretary of Health, Education and Welfare, Elliot Richardson; the Secretary of Housing and Urban Development, George Romney; the Secretary of Commerce, Maurice Stans; and, from the White House Staff, Herbert Klein, Communications Director, presidential counselor Robert Finch and special consultant Leonard Garment (4.38). Trade sources see "excruciating fights ahead" over this group's intervention, especially over "the FCC's failure to make firm decisions about whether CATV should be a common carrier" (4.39), and there is speculation about whose side the President's committee is on and why (4.40).

Bowing to "the exceeding complexity of the legal, social, technological and scientific issues, questions and implications involved" in CATV, and sensing that "unless there is an immediate and temporary cessation of the present precipitous pace of development of the industry in this state, the necessary deliberations of the legislature will be rendered academic by the rapid march of practical events" (4.41), the New York legislature passed a bill, signed by Governor Rockefeller in June 1971, prohibiting the franchising of new CATV enterprises for one year. This law, whether enacted in the interest of the general public or merely that of CATV's competitors, is not amicably regarded by CATV. Donald Taverner, the outgoing president of the National Cable Television Association suggested that local governments should grant franchises to CATV under FCC guidelines and push state laws out of the way altogether (4.42). This preference for the FCC, whose jurisdiction over CATV is uncertain if not ancillary to regulation of television broadcasting is touching testimony to the difficulty of telling, as in the limerick about buggers, who's doing what and with what and to whom. The public need for access to telecommunications for learning is too important to be left caught in the glacial inertia of established educational institutions, the opaque politics of common carrier regulation and the frenzied commercialism of the mass-media tradition.

V. CONTENT AND MARKETS: ISSUES IN PUBLISHING

Independent of conduits or linked with them, publishing is a gate through which personal contributions in every medium are distributed and pass into the social memory; it is where tolls are exacted, rewards distributed and critical judgments made about degree of aggregation and quality.

Printing technology's inherent capacity for cheap mass production was not immediately exploited in mid-fifteenth century. Editions of 200 copies were common but the printing of more than 1000 copies was a rare event. The struggle to convert potential into actuality presented a circularity strikingly parallel to that facing the open universities and CATV. Capital for stocks of paper, metal and finished books was difficult to raise. The market that the early printer-publishers in their practical commercial spirit could firmly count on was limited (5.1). They looked for profitable returns but they "could rely on a steady sale only of established works like the Bible, Donatus' grammar, prayer books and so on. The bulk of the works printed in the first century of printing were the old works, familiar to the region where the printer was at work" (5.2). The only guaranteed demand came from what we now call the learned professions (5.3). Even that was narrow, as reflected "by the experience of Aldus Manutius who was the first to produce books in large quantities and to sell them at relatively low prices. In 1515 he was compelled to reduce the prices of his stock of Greek books in order to sell them at all" (5.4).

Early books, big and unwieldy as slavish imitations of manuscript typography and format, also may have discouraged buyers. Not until the development of small compact type in the early 16th century were books of handy size printed (5.5). It is uncertain, however, whether technology was the governing market factor. As Archer Taylor has pointed out, "the earliest printers may not have perceived the opportunities which lay in printing in the vernacular, but it is uncertain whether these opportunities existed. A public which was able to read developed rather quickly, and quickly bought up vernacular books in the 16th century. We can infer that a purchasing public able to read the vernacular had not existed earlier" (5.6). As we have noted for the open universities and CATV, it is difficult to cut into a situation where demand is not evident without a supply to meet it and where the risks of investing in supplying an uncertain demand are high.

Publishing had censorship built in, "exercised by professors before the church undertook to condemn books". This was a direct consequence of the fact, reflecting common control of conduit and content, that "the printer-publishers carried on their work in close connection with the university: the books were written by university professors, were read and corrected for errors of printing and fact by men in universities or trained by it, and were sold most freely in university circles" (5.7). Nothing suggests that CATV operators and the entertainment industry would behave differently if in control of both conduit and content.

Diversity of access to the print medium was severely limited at first. The early printers hedged risks by printing at the cost of the author or his patron, sharing the costs only in exceptional cases. The need for high capital investment and the drive for profit meant that "to original genius and unknown authors, the early printers offered comparatively little encouragement" (5.8). By the mid 16th century, book sellers rather than printers laid out the capital for publishing (5.9). Today, the book publishing industry is more independent of both printing and bookselling. It is also less concentrated than broadcast television and less limited to local distribution than CATV. Control of both content and vessel therefore has less significance in publishing than in telecommunications.

Fulfillment of the opportunity guaranteed by the First Amendment is not financially prohibitive. Economic constraints on diversity of access to print have been sharply reduced by advances in technology that enable an edition of two thousand copies or so to break even in the book market. An edition of this size is small relative to the American population which, if nothing else, can all be reached through the mails. It is also small relative to the geographically concentrated groups of 10-20 thousand commonly used in financial planning for CATV facilities. Economies of scale in book production are thus achievable, if not very profitable, at relatively low levels of aggregation.

The hand-in-glove partnership of schooling and publishing characteristic of early printing still persists, albeit uneasily. Textbooks remain the most lucrative publishing product, although publishers complain of delays of up to three years between contracting for a book to be written by an author and its readiness for market. They also bemoan softness in the textbook market caused by college instructors "placing relatively less reliance on traditional textbooks and more on innovative materials" (5.10), including selective reproduction through dry copying and other fruits of 20th century technology capable of bringing unit copy costs to attractive levels for widely varying degrees of aggregation. On the other hand, open universities, to the extent that they achieve high aggregation and little direct meeting between learners and teachers, can lend themselves to widespread use of standardized materials.

Educators, although sharing as authors in the profits and the responsibilities of publishing and still representing its major market, complain of profit-induced short-changing of quality. A. Poulin, Jr., a professor of English, for example, charges that

"the principle is not for the editor to use the best and most effective material he can find, but rather to select whatever material his budget can afford." He concedes that "teachers may be passively willing to settle for [the standard mediocre textbook] because it is a textbook, presumably written or edited by a scholar or expert and published and because they sense they can't do anything about it anyway", adding that "one cannot possibly overestimate the naiveté of even professionals" (5.11).

In a similar vein, the director of the Educational Products Information Exchange Institute reported in Congressional testimony that his organization's "investigation in the area of textbooks indicates that under 1% of the approximately 14 thousand textbooks being sold to schools has been systematically shaped through the learner tryout and revision process." (5.12) Again, the responsibility is not solely industry's. The U. S. Office of Education's penchant for artificial dissemination of dubious research results and its subservience to the self-serving satraps of schooling make it persist in funneling money to schools for acquisition of materials and in neglecting institutions outside schooling better equipped for large-scale long-term experimental and developmental efforts (5.13).

Publishers can justly point out that the no-significant-difference findings are not of their making. Given the disagreement, both within the education profession itself and among its lay critics, about proper learning goals and strategies, concentration on profit making is understandable. However, when rationalized, as by Raymond Hagel, the board chairman of Crowell Collier and Macmillan, by the assertion that "change comes about gradually, usually the result of many small innovations, individually applied", faith that the profit motive will improve learning seems naive. It is explained, if not justified, by Hagel's further observation that he "may expect no reward for being first - only for being right ... against a background of intense but constantly changing enthusiasms" (5.14).

Not being first may indeed be the key to being right within the confines of policy dedicated primarily to corporate survival, as attested to by the unhappy fate of publishers who rushed into educational technology in the heyday of the 1960's. The market for new computer and moving picture technologies in learning remains as chancy today relative to the entertainment market as the market for books in Greek or the vernacular was in the fifteenth century. Persistent academic complaints of lack of commercial interest in new technologies learning ventures are therefore quite understandable.

Indeed the new technologies may well be suffering greater disadvantages than did movable type in the fifteenth century. There is no backlog of materials for learning with the aid of computers at all comparable to the vast backlog of manuscripts available for printing in the fifteenth century. Estimates of the cost of developing a computer-mediated college course range from 100 thousand to one million dollars depending on aspirations, the vagaries of cost accounting, and the desired extent of field testing of the new materials. Even where programmed instruction materials in book form are available, their conversion into the computer medium takes high investments, owing significantly to the absence of any widely accepted language in which these programs may be expressed for computer use.

The market is inaccessible. Even if demand were clamorous, telecommunications, as already noted, is far from ready to help meet it though widespread electrical distribution of services to learner terminals from centralized sources. Supplying programs to enough local computers to pay off investment in the programs is thwarted by software idiosyncracies causing rampant mutual incompatibilities of computers, even among the same models of the same manufacturer.

But there is no market. The circularities inherent in bootstrapping from experimental ventures meeting inadequately perceived needs toward real demand large enough to dilute high aggregate costs into acceptable unit costs are as starkly evident now as they must have been to Aldus Manutius. Just to achieve with computers the minimal compatibility taken for granted in print technology entails concerted action by many interests on a national and international scale, not merely small innovations individually applied toward immediate profit.

Perhaps, in some realms, there should be no market. Among the many varied tasks advocated for computers in learning (5.15) their use for drill-and-practice or tutorial in arithmetic stands out as experimentally far advanced, yet the potential value of such use should be challenged. Deploying computers for teaching arithmetic skills seems like a most ingenious perversion of learning and misdirection of resources. The idea, in essence, is to use computers at great expense to help people learn how to do something that computers themselves can do much better at less expense.

A very rough estimate of the minimum current national expenditure on the teaching of arithmetic skills puts it in the range of 3 to 8 billion dollars a year. Some of this is justifiable as an introduction to mathematical ideas. More of it is rationalized on the dubious ground that arithmetic, like late unlamented rote Latin studies, is a general mental muscle builder. Most of it merely makes children more or less able to do sums, differences, products and long division, on the ground that these are useful skills in life.

But it is questionable how useful these skills are in a civilization laden with cash registers that calculate the change and in which mechanical or electronic desk calculators permeate every accounting office. Balancing one's check book is the most plausible answer that comes to mind. Yet if the price were right the TOUCHTONE® telephone or similar instruments coupled to common carrier telecommunications could supply these menial services as readily and widely as weather forecasts or the time of day.

The telephone companies currently invest about 9 billion dollars a year in the expansion of telephone plant . It seems worthwhile questioning whether the comparable investment made in drilling arithmetic into people might not more effectively be diverted into developing the facility for every citizen to do his arithmetic over the phone or else at least into following the Japanese example of installing electronic desktop calculators, soon expected to sell for less than $100 in U.S. department stores, throughout the senior high school system (5.16). The question should certainly be asked before investing in computers for drilling arithmetic into people.

The market uncertainties for computer-aided learning also plague the moving picture realm. A study by General Learning Corporation in 1968 (5.17) found that virtually no private companies were producing instructional television materials. The situation has not significantly changed since. The National Academy of Engineering's

Committee on Telecommunications estimates that "the cost of creating high quality new material for instructional TV services especially adapted to two-way learning is likely to be in the range of 3000 to ten thousand dollars per hour or more". It concludes "that the only way that programming of this quality and cost can be justified is through large audiences, just as in the case of entertainment TV" (5.18).

Reaching large audiences or many individuals through schooling requires overcoming both the specific hostility of educators toward new technology and their general inertia. If recorded moving pictures are to be distributed through conventional transportation, the lack of adequate storage facilities described in the next section is one of many obstacles to be surmounted. For electrical distribution to be practical either through schooling institutions or, bypassing them, directly to the public, the issues of public access outlined earlier must be resolved. The NAE Committee on Telecommunications' assumption that a high degree of aggregation is necessary to justify quality is examined in Section VI.

Who is willing to pay for learning through moving pictures is far from clear. Schooling's grip on the public learning dollar will not be lightly broken. Unguided private investment has more attractive alternatives, partly in learning paid for by industry for specific training, but mainly in entertaining the general public. The relative magnitudes involved may be understood by contrasting approximately nine million dollars which the Corporation for Public Broadcasting granted to national public television production centers for the entire 1971-72 season (5.19) with revenues that entertainment earns in 90 minutes of prime commercial advertising time at 100 thousand dollars per minute (5.20) and with total television broadcast revenues of about 1.5 billion dollars in 1970 (5.21). Audio tapes for entertainment produce revenues of about 500 million dollars yearly, which is 30% of a total disk/tape entertainment market of 1.8 billion dollars, and this industry expects an average growth of about 19% per year (5.22).

Entertainment revenues are small compared with a 66 billion dollar annual national outlay for schooling but enormous compared to the almost invisible fraction of instructional expenses not devoted to salaries (5.23) and available to educational management for reallocation. One trend suggests that far from growing, the market share of education will decrease in the future. A recent survey of the market for closed circuit television equipment (5.24) finds that education represented a 33% or 30 million dollar share of the market in 1970, a share that would decline to 29% of the market by 1975 and to 25% by 1980, although rising in absolute value.

While learning is unfailingly mentioned among the objectives to be served through new technologies, the only substantial backlog of materials ready for publishing in the new media is the reservoir of audio and video materials accumulated in the film and broadcast entertainment industries. Lively prospects for this market have touched off multi-cornered controversies over rights among actors, production organizations, the broadcast industry, the film industry and other potential beneficiaries. In these controversies, the interests of learning are overshadowed by struggles for control over both conduit and content and by debates over the relative projected growths of the pornography and old movie markets (5.25). In sharp contrast with the history of printing, the pattern for publishing and distributing materials in the new technologies will, without public policy guidance,be controlled mainly by the profit traditions of moving picture entertainment, less by the learned professions and little, if at all, by a "sufficiently liberal and comprehensive" view of the public interest.

VI. ACCESS TO STORAGE: THE LIBRARY CRISIS

Books today are justly regarded as a primary medium of social memory. However, their impact on learning is far from pervasive. Individual ownership and storage of books is expensive enough to restrict book collections of even the well-to-do to limited working collections. Not even the great national libraries, the Library of Congress, the British Museum, nor the Bibliothèque Nationale can lay claim to being comprehensive in themselves. Of the seventy five thousand libraries in the United States, 50 thousand are in public and private elementary and secondary schools and some four thousand in junior colleges, colleges and universities (6.1). The general public depends for library service on about 11 thousand public libraries and branches concentrated in cities and towns. Universal access to book collections is far from reality.

The very idea of free public access to books is recent. Proprietary and subscription libraries, public in being open to anyone able to pay, did develop in New England throughout the 18th century. But only in 1833 did the first municipally supported free public library get established in Peterborough, New Hampshire. In 1835, New York State enacted a law permitting tax-supported free library service through school district libraries open to the general public (6.2). In a report on the Carnegie Libraries ⟶

he made in 1919, Alvin Johnson, confident that an overwhelming majority believed in public libraries, nonetheless cited continuing opposition by "doctrinaire individualists ... socialists ... demagogues... religious zealots ... authors, publishers and book sellers" (6.3). He also pointedly commented that "for the present the public authorities are scarcely anywhere fully alive to the necessity of providing free libraries, and in many parts of the country the library movement has as yet made little impression" (6.4). As for content, said H. L. Mencken in comments similar to current arguments about the quality of audiovisual materials, "go to the nearest Carnegie Library and examine its catalogue of books. The chances are five to one that you will find the place full of literary bilge and as bare of good books as a Boston bookshop. Almost everywhere these Carnegie libraries are in charge of local notables and among these notables there are always plenty of wowsers" (6.5).

Whatever the criteria of selection, the sheer volume of contemporary new publication and the wide disparity in library sizes and resources continue to contribute to major inequities in access to library resources. While the Library of Congress acquires 400,000 volumes a year, and Harvard's library 60,000 volumes, the average public library serving an area with 50 thousand inhabitants or more added only about 2 thousand volumes to its collection in 1965 (6.6).

More serious still, libraries share the deep trouble of service industries. General library activity, however poorly measured by inventory of volumes and by volumes added and circulated during a year, roughly doubled by all these measures in the period from 1955 to 1965. However, in that same period, operating expenditures roughly tripled. In the period from 1964 to 1968, when enrollment in colleges and universities increased by 45%, the number of volumes held increased by 34%, professional library staff by 46% but library operating expenditures by 107%. The time delay between receipt of a book and its placement on the shelf after cataloging has risen to months in large libraries and the process has been estimated to cost $18 for a $10 book (6.7).

The details of the library crisis and of the potential role of new technology in meeting the crisis are too many and their complexity too great to permit detailing here. Gerard Salton has recently given a summary of the current state of affairs and numerous specialized reports have been prepared over the past decade (6.8)

Libraries in some form remain essential as the only practical was of storing the bulk of social memory embodied in old books, but it should be clear that replicating book collections in book form for wider geographical distribution and broader access is not a feasible policy. Why compact microform publishing (6.9) and bringing the store to the learner through telecommunications seem appealing is therefore understandable, although the economics of libraries and of alternative systems are interlocked with various vicious circles.

The storage of moving picture recordings is in much worse shape. In the earliest days of photography, Oliver Wendell Holmes foresaw the growth of "such an enormous collection of forms that they will have to be classified and arranged in vast libraries, as books are now" and proposed "the creation of a comprehensive and systematic stereographic library, where all men can find the special forms they particularly desire to see" (6.10). Today, moving picture distributors and repositories issue lists of their offerings or holdings, but standards for description are absent; tedious previewing is generally the only way of finding out what's on a film or tape. The equivalent of a union catalog for a university or of the catalogs of great national libraries is non-existent. The largest collections of visual materials, belonging to the entertainment industry, are closely held with an eye toward the golden promise of the cassette market.

Acquiring visual materials for previewing or showing takes careful advance planning. The National Instructional Television Center recommends ordering telecourses at least six weeks before the starting date of a series and requires orders by July 15 for courses beginning in the September and October peak period (6.11). The little use made of materials available from the National Instructional Television Center, the Great Plains National Instructional Television Library and similar institutions is primarily at the elementary level. The so-called learning resource centers of elementary and secondary school systems that participated in the audio visual boom of the 50's and 60's tend to carry a stock of visual materials but college and university libraries have retained both their traditional names and their traditional aversion to non-print collections, an aversion justified in part by lack of demand.

The low quality of available materials is one reason cited for low demand. The Commission on Instructional Technology reported that "the evidence on the quality of most available programs is ... discouraging. For example, the National Instructional Television Center, established a few years ago to winnow out and distribute good instructional programs, found only a very small fraction of the programs scanned worthy of national distribution " (6.12). Others see the problem as reluctance on the part of college teachers to accept teaching of materials in their major field by a professor from another institution, a delicate balance between professional responsibility and featherbedding (6.13). Whatever the cause, use of visual materials in higher education is small and peripheral except in a few institutions where instruction by television is the policy. Even in those cases the medium has not taken root and it is used only under administrative pressure or by very few individual faculty members interested in experimenting

Popular success of Sesame Street and the pressures of entertainment assure widespread distribution of some moving picture materials. But whatever learning takes place this way will take place neither under the control of professional educators nor necessarily by choice of the learner. He who pays the piper will call the tune. If the learning public is to be served as it wishes, the multiple interests vying for its attention with small innovations, individually applied will need to be orchestrated through far more harmonious efforts than evident until now. Otherwise, for want of storage and distribution facilities learners will not be reached; for want of learners, learning materials will not be produced or criticized; for want of high quality learning materials learners will not learn and, for lack of demand, storage and distribution facilities will not be established.

VII. PERSONAL CONTRIBUTIONS TO MEMORY: RIGHTS AND LIMITATIONS

If the embodiments of distribution, publishing and storage functions seem complex and ponderous, subject to both vast forces and great inertias, it is at least in part because their usefulness to learning in a democracy must be measured by their ability to serve practically everyone. How well everyone is served -- what learners can learn -- is determined also by who does the talking, who the listening and by whose choice. Developing the means for broad enough access to talking and to listening to support economies of scale is subject to all the transitional vicissitudes that should by now be familiar.

A universal right to contribute to social memory through writing and to draw from it through reading is now accepted in principle in the United States. Literacy serves so many important personal and social purposes that the necessity of public investment in literacy training is established in principle in spite of recognition that how persons will use their literacy will vary widely in quality and in significance. In practice also illiteracy among Americans has dropped from 20% in 1870 to about 2% in 1960, although for non-whites the respective percentages are 80% and 10% (7.1).

Investment in literacy training has been matched by investments in the technology of writing and printing toward economies of scale that have brought the cost of basic writing tools and materials within the reach of every man. 19 cents buys a ballpoint pen and 35 cents a pad of paper and this is sufficient to set anyone up for writing. The loan of a pen and the gift of a piece of paper are had as freely as the time of day. A new portable typewriter can be had for about 30 dollars or roughly half the cost of a black-and-white television set.

Writing has an editing technology of the utmost simplicity. Crossing out and rewriting interlinearly is the most obvious, least expensive and most widely practiced editing process. Cutting and pasting takes tools, but common ones that serve other purposes as well. Paste has largely been supplanted nowadays by transparent adhesive tape which, although a feat of high technology, is widely distributed at prices low enough to be within the reach of every person.

Replication technology for writing and printing has recently developed to a point where so wide a range of tools and techniques is available that a satisfactory economic balance can be struck for a very wide range of cost, volume and time constraints. Where very low cost is essential, time not critical and volume very low, manual copying -- once the dominant technology -- still remains available. Carbon paper, both the traditional kind and that based on the high technology of micro-encapsulated materials is easily within the individual's reach. Spirit duplication is widely used in schools and is affordable by the home or small group.

Dry copying technology, although uneconomical for one person, is increasingly widely available on a shared basis, in offices and coin-operated machines at supermarkets and other public locations. Finally, the higher-volume, higher-speed, higher-cost replication technology is widely available through job shops, a characteristic of print technology from its earliest days. "Printing", Hay points out, "spread at a phenomenal speed from

Mainz and by the 1490's each of the major states had one important publishing centre and some had several ... By 1600 ... a press was to be found in nearly every town of some size" (7.2).

Thus the basic means of authorship are readily available to the individual for practice, self training, the keeping of personal records and other entirely personal uses as well as for person-to-person communication and for the social memory even of small groups. Necessary intervention by professional scribes is a thing of the past. Through the common carrier services of the post office, written materials can be distributed by anyone to anyone anywhere, albeit the costs will seem non-trivial even to someone running for local office in a small town. Common literacy encourages common attention to any limitations or abuses of access rights to distribution, publishing and storage. Even authoritarian regimes find it impossible to thwart entirely the distribution of writing among literate people, witness , for example, the circulation of Solzhenitzyn's writings through the Soviet "samizdat".

This comparatively free flow and low cost of writing owes much to a technology without significant compatibility problems. No artifacts other than eyeglasses need intervene between a page of text and a reader. Replication technology needs only to copy faithfully, not to interpret what it copies ; it therefore accommodates any graphic image. Except for occasional minor difficulties with idiosyncracies of penmanship, the massive investment in literacy training assures sufficient standardization of penmanship for mutual intelligibility. The type fonts used in typewriters and printing presses have long since attained a degree of standardization that preserves the integrity of the basic geometric shapes of printed alphabetic symbols within wide variations of style. Even newer special type fonts, like the E13B font found on the bottom line of every check, are products of a careful design compromise between the need to maintain intelligibility for human readers while enabling computer recognition of the characters by magnetic or optical techniques.

In contrast, realizing the potential of computers, not only as aids to learning, but for numerous other personal services depends, as already noted, on agreement about inadequately perceived needs and on bootstrapping these needs into supply and demand for distribution, publishing and storage. Present limitations on personal ability to contribute to or draw from computer services and consequent public unfamiliarity with their potentials weigh heavily on the bootstrapping process and reinforce its inherent and debilitating circularity.

The programming languages a person must use to make a computer do his thing necessarily differ from the vernacular. The vernacular is neither precise enough for instructing computers nor, indeed, interpretable by computers through any means yet known. Attempts to restrict use of the vernacular to a circumscribed and precisely designed set of locutions has either run afoul of human inability to stay within the prescribed boundaries or has rapidly shaded toward the type of language that is in fact used for programming, namely an abstract precisely defined language in which symbols drawn from the vernacular, if they occur at all, occur in unfamiliar and specialized usages. Worse yet, there is at present a wide variety of mutually incompatible computer languages and dialects.

FORTRAN users are unintelligible to COBOL users and those versed in one of the several author languages for computer aided instruction need additional training to use another. It is also sad but true that, at present, a program written in a given language, say FORTRAN, for a particular computer, will not necessarily run without modification on another FORTRAN-handling computer even on the same model made by the same manufacturer.

If the potential of computers is to be realized, compatibility will, as noted earlier, have to be sought through concerted public actions. The merits of investment in wider computer literacy comparable to investment in conventional literacy will also have to be considered in public. At least two paths toward computer literacy can be discerned with different consequences for aggregation, One is investment in learning to use a computer language to do one's bidding in a wide variety of tasks, comparable to investment in conventional literacy and, like it, striving toward maximal personal command of the medium. The other is training in a limited repertoire of stylized responses adequate to avail oneself of services which, like computer aided learning, are supplied and controlled by others.

influenced by technology in the manner of Figure 2, the choice remains a matter of public policy.

In moving picture technology, even more than in computing, the capability of personal contribution to memory has been a privilege of relatively few professional scribes augmented by a semi-professional artistic avant-garde. Moving picture makers are concentrated within their industry, while the practitioners of computing have spread more widely throughout all industries, commerce, government and, to a lesser degree, schooling, although they are much less widely distributed than conventionally literate persons.

Schooling in moving pictures to date seems limited at best to putting an 8 mm or Super-8 camera in the hands of a child, telling it to shoot and then playing back the result after the film has come back from a remote processing laboratory. The effort is justified in the glowing but vague terms of creativity, sharpening powers of observation and similar aims. There is little emphasis on the didactic and workaday concerns that surround writing and computing technology. The didactic moving picture is typically made by professionals and shown to a passive audience.

This is intelligible in part for historical reasons. Traditions of learning strongly shaped the early history of books. The first electronic computers emerged in universities and research centers. The modern equivalent of the scholar-printer is the scholar-computer user, the physicist, sociologist or linguist who has mastered the tools of computer technology and applied them to his own discipline.

By contrast, moving pictures have developed primarily in the traditions and standards of mass entertainment. In the United States, the cholar-movie maker is absent from the wider academic scene. He is found mostly in schools of communication, or he may have turned to movie making through participation in one of the several curriculum development efforts that flourished from the mid 50's through the 60's. In those universities where audio-visual facilities have developed, they are enclaves of professional scribes, glorifications of a "you want to show a movie - we'll supply the projector and projectionist" service or else service-oriented derivatives of research efforts in audio-visual instruction, with results that are only marginal, as pointed out in the last section.

Whether the limitation of the moving picture medium to mass entertainment or to passive viewing of generally low quality didactic material is of the essence or merely an accident of historical development is an open question. The formal research evidence is sparse, mixed and pedantic. Chu and Schramm reveal that "the use of visual images can facilitate the association process. Otherwise, visual images may cause distraction and interfere with learning," the point being that "the child's attention may be distracted by certain objects or actions which may have nothing to do with the task being learned. That is, certain incidental learnings may impair the intended learning" (7.3). The distinction between "intended" and "incidental" learning is on the dividing line between schooling and a broader view of learning, and we noted in the introduction that Chu and Schramm have explicitly limited their attention to instructional television,

The origin of the moving picture in entertainment traditions arouses in educators disdain like that of the librarian who told a meeting in 1879 that "schoolboys or students who took to novel reading to any great extent never made much progress in afterlife. They neglected real practical life for a sensually imaginative one, and suffered accordingly from the enervating influence" (7.4). On the other hand, the incursions of educators into movie making are afflicted, as in Singer's words, with ponderousness, pedagogy and poor performance (7.5). A wider public has not yet had a chance. Not everyone is a

Shakespeare but 98% of all Americans have a crack at writing. Without a wider base for personal expression in moving pictures, the learning potential of the medium is not likely to be realized.

At present, the entry price for personal expression in moving pictures is one hundred to one thousand fold that for writing. The movie film embodiment is also plagued by technical problems difficult for the amateur to overcome. Everything that is so simple in writing is complex in movie making. It need not be so. Videotape, albeit still more expensive a medium to enter, offers possibilities for easy self expression which have not escaped the attention of the counter-culture moving picture buffs whose publication, Radical Software (7.6), is supported by the New York State Council on the Arts.

There is now, indeed, a wealth of new alternatives to movie film as embodiments of moving pictures, among them videotapes of many varieties in reels, cassettes or cartridges, and including more exotic technologies like CBS' EVR and RCA's Selectavision (7.7). The full development of these technologies still lies ahead; it is, however, guided primarily by the interests of the entertainment industry in securing a market at the highest and hence most profitable levels of aggregation. These markets will be opened by cable distribution or are already accessible through conventional channels which will distribute recordings for playback in the home.

In the recent past, poor designs and doubtful reliability have made it difficult to play back a recording made on one instrument on any other, or even on the original instrument, a situation that is improving somewhat with experience. Unfortunately, competitive pressures have driven American designers to strive for market control through maximum incompatibility among their products, including the low-cost playback devices needed at the home end of the cables or the mail. What effects Japanese efforts to standardize will have on the market is not yet clear. Thwarting individual creation or copying of recordings is also an important design objective. This scandalous situation is understandable in an industry where piracy of sound recordings is the way of life ("'Honest' Pirate to Hit Bill for Disk Copyright", cries the Variety headline, distinguishing these monopoly-fighting Robin Hoods from "shyster pirates") and where the archaic property law is Byzantine in its exquisitely tortured complexity (7.8). For example, Melville Nimmer points out that "we will not be certain, until we have a Supreme Court decision on the question, whether videotape may be the subject of copyright under the present U.S. Law" (7.9). He traces the uncertainty to the 1908 decision on the White Smith Music Company case when the Court declared piano-player rolls not to be copies of the music they contained on the ground that something is a copy only if intelligible through unaided human senses.

But, in the broader public interest, tout comprendre should not be tout pardonner . At the same industry conference where Nimmer cast his cloud over videotape, the president of Capitol Records said that were he a cassette he'd panic, what with "all those men ... trying to get into my box for some nefarious purpose"; he described the consumer as one "expected to perform in the robot manner described in the market surveys"; and he predicted that "hardware producers would not heed the consumer, wholesaler, or retailer, but move forward ruthlessly to develop their separate systems" (7.10). Only the consumer, asserting himself as a potential contributor to social memory, has an interest in driving this industry toward enabling personal expression in the moving picture medium and broadening this medium beyond the confines of poor pedantry and pure pelf. It took four hundred years to establish, in Richard Altick's phrase, the revolutionary concept of the democracy of print (7.11).

VIII. PIRACY AND FAIR USE: COPYING TECHNOLOGY AND THE LAW

Confusion and uncertainty about the legal status of property rights in information contribute another ring to our circus of interlocking conundrums. Tooling up at great cost to produce something which is then easily stolen and reproduced at lesser cost by a competitor is the stuff of entrepreneurial nightmares. Publishers, for example, fear tht existing copyright legislation does not adequately protect materials for computer-aided instruction (8.1). Who owns what in the British Open University sets academics one against the other and all against the administration. American universities have scarcely begun to awake to the problem. Whether or not photo negatives are tangible personal property qualifying for investment tax credit is a lively issue between film companies, the Internal Revenue Service and the courts (8.2). *Telecommunications Reports* itself, distressed by evidence that certain subscribers are duplicating its contents for distribution and resale to others, threatens to commit suicide (8.3). The movie makers and the cable operators come to terms they hope will influence pending copyright legislation (8.4) and are denounced for it by the National Association of Broadcasters weeping crocodile tears for the public interest (8.5).

The White House Office of Telecommunications Policy once gave up trying to soothe the fighters and *Variety* reported "Compromise on Cable Copyright in OTP Ashcan". Less than three months later, a compromise was hammered out, but on terms less favorable to cable than envisaged by the FCC. Christopher Lydon reported in the *New York Times* Congressional speculation that "there would be no interference in a plan that the powerful private interests all accepted". A few days later, his colleague Jack Gould could both comment that "controversy galore will attend the evolution of cable TV ... but the layman can leave their resolution to the experts" and recognize two columns over that "the enticement of cable is self-evident: it affords control" (8.6). We cannot attempt here to follow all these threads, but limit ourselves to illuminating why technology inflames such quarrels. Our example emphasizes the impact of property rights on questions of storage and individual access to printed materials.

The vesting of property rights in printed matter did not follow immediately upon the invention of printing. The reprinting of popular books by competing printers was commonplace in the early days. Authors began to be paid in cash only in the 17th Century and were given big sums of money beginning only in the early 18th Century (8.7). In England, the copyright act of 1709 gave property rights to the author of a work but the prevailing practice is for authors to sell their work to publishers for varying combinations of lump sum and percentage-of-sale royalty payments.

The basis of copyright is the public interest in learning, not inherent private property rights. Section 8 of Article 1 of the Constitution gives the Congress the power "to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." The Copyright Act of 1909 is the current statutory reflection of Congressional exercise of this authority. So long as buying a copy of a printed book or consulting it in a library was the only practical and economical way to get at it, copyright worked in fact as well as in principle. Vessel and content were effectively inseparable.

The advent of telecommunications and, especially, of computers and dry copying technology are radically changing this situation. As in the case of early photocopying, high cost initially kept these technologies from making major inroads into the publishing market. But computers are opening up the possibility of providing reference services otherwise available only through publishers' copies, of making derivative works such as indexes or tailored compendia and of providing many other potentially competitive services (8.8). Microfilm technology threatens the supremacy of print-on-paper as a publishing medium and is better suited for linkage with computer and copying technology (8.9). Of greatest direct significance to the individual teacher or learner, dry copying techniques, as noted in the previous section, have made it economical to make selective extracts from books and journals. Recall the publisher's chagrin at the inroads on traditional textbooks made by reliance on "innovative materials".

The balance between property and piracy, between reaction and progress is complex. The new technologies have shattered the physical inseparability of vessel and content, and broadened our conception of "copies", thereby focusing attention on the very peculiar and very poorly understood economic characteristics of information and of knowledge, whose cost and value are now at least understood to be distinct from those of their material media. Exploring and classifying the implications of this fundamental fact is essential to the rational resolution of quarrels over property rights in this realm.

Unfortunately, as Kenneth Boulding rightly points out, only a very few economists have taken an interest in the economics of information, consistent with his charge that "economists have neglected the study of technical change at the structural and micro level to the point where we are quite incapable of answering many of the most important questions of our day" (8.10). The patent and copyright lawyers greet fundamental questioning in this area with all the enthusiasm of trial lawyers at a hearing on no-fault insurance.

Photocopying began in all innocence as a way to promote public access to a national library resource. In 1901, the Library of Congress provided for photocopying selected materials in its collections, recognizing the value to library users and to "the progress of science and useful arts" of extracting materials from library collections for personal use with greater facility than through the laborious process of hand copying. According to Verner Clapp, under the copyright law in effect in 1901, "the infringement of copyright in books and other works reproduced from type was specified as consisting in unauthorized printing, publishing, importing or offering for sale copies of the copyrighted work. Merely to copy did not infringe" (8.11).

Clapp goes on to argue that a prohibition against "copying" subsequently introduced in the Act of 1909 was based on usage in which the word was synonymous with printing, ... or offering for sale, hitherto the only viable technological means of infringement. Since the Librarian of Congress himself participated in the drafting of that act, Clapp suggests that "the exclusive right of copying, in the sense of making single copies, thus seems to have been created quite inadvertently, as the result of a nicety of legislative drafting, by the very public official who might have been supposed to be the last by whom this would have been done!" (8.12).

For a while the ensuing conflict between publishers and copiers was muted by appeal to a traditional Doctrine of Fair Use under which a "court can find that under certain circumstances the unauthorized printing or publication of a copyrighted work does not justify the infliction of penalities for infringement" (8.13). This doctrine underlies the Gentlemen's Agreement on library photocopying entered into in 1935 by the American Council of Learned Societies and the Social Science Research Council with the National Association of Book Publishers and later with its successor, the Book Publishers Bureau (8.14). The scholarly world thus eased into convenient and effective copying practices which, with the advent of dry copying, rose to a crescendo of what publishers see as shameless piracy.

When library copying is piracy and when an act to promote the progress of science and useful arts is a matter now before the courts in the case of Williams and Wilkins vs. the United States of America (8.15).
As in the brief history of CATV, one case is unlikely to settle much.
In keeping with government efforts to aid the flow of medical information, the National Library of Medicine in 1956 substituted photocopying of articles for interlibrary circulation of journal volumes. This practice,

undertaken consistent with the Doctrine of Fair Use, was challenged on April 28, 1967 when the Williams and Wilkins Company of Baltimore, publishers of medical and other scientific books and journals, asked the National Library of Medicine for a royalty of two cents per page on copies. The general counsel of the Department of Health, Education and Welfare gave the National Library of Medicine an opinion which supported its photocopying practices. Understandably, the practice also drew widespread support from the library community, including enlightened university librarians.

Accordingly, the National Library of Medicine, after having suspended its copying, informed Williams and Wilkins of its intent to resume. On February 27, 1968, Williams and Wilkins filed in the U. S. Court of Claims a suit against the United States alleging that the National Institutes of Health and the National Library of Medicine had infringed its copyright through its practices and reiterating its wish to be paid a royalty on each copy to compensate it for loss of sales. The case came to trial on September 9, 1970. As of August 1971, the briefs are in, but no decision is expected for at least a year.

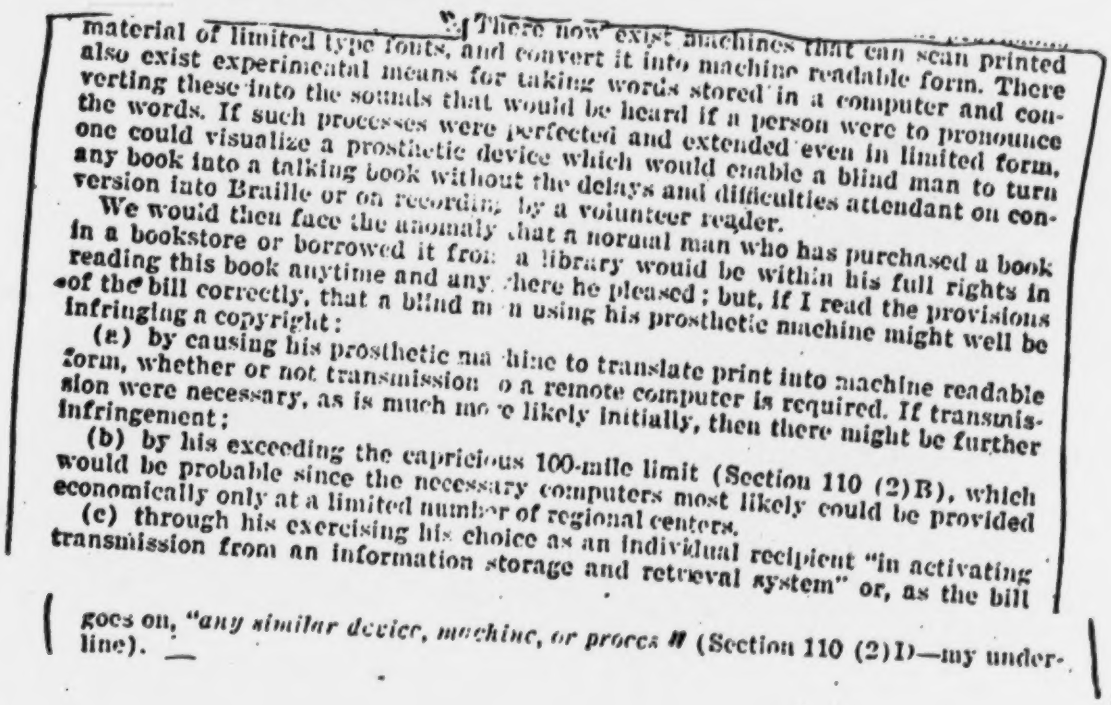
The hopes and woes stirred up by all the confluent technologies of Figure 1 have swirled together in battles over the Copyright Revision Bill. This bill is still stalled in the Congress several sessions after the Register of Copyrights formulated the first version, hopeful of updating the 1909 Act but unaware that events had already bypassed him.

S.597, the version of the Copyright Revision Bill introduced in the 90th Congress, attempted to limit certain exclusive rights of publishers by exempting from infringement liability certain performances and displays distributed by telecommunications transmissions for learning purposes.

However, Section 110 of the bill restricted two of the exemptions to accommodate certain issues arising from the battle between broadcasters and CATV operators. Section 110(2)B granted exemption from infringement liability only if "the radius of the area normally encompassed by the transmission is no more than one hundred miles". Section 110(2)D made exemption contingent on condition that "the time and content of the transmission are controlled by the transmitting organization and do not depend on a choice by individual recipients in activating transmission from an information storage and retrieval system or any similar device, machine, or process" ( ). Both restrictions have serious implications for aggregation and individual choice.

In subsequent testimony before the Subcommittee on Patents, Trademarks and Copyright of the Senate Committee on the Judiciary, it was argued that, as a consequence, "programmed instruction of the linear kind where each student is presented with precisely the same sequence of questions as every other, could legitimately take place if time and content of transmission were controlled by the transmitting organization. However, the use of branching instructional programs where the future course of instruction, the nature of questions and so on depends on prior responses by the student might well constitute 'a choice by individual recipients in activating transmission' and therefore an infringement!" (8.16).

The capricious potential side effects of provisions germane to battles between broadcasters and CATV on processes of primary interest to publishers threatened by computers are further illustrated by the following excerpt from the testimony.



[8] There now exist machines that can scan printed
material of limited type fonts, and convert it into machine readable form. There
also exist experimental means for taking words stored in a computer and con-
verting these into the sounds that would be heard if a person were to pronounce
the words. If such processes were perfected and extended even in limited form,
one could visualize a prosthetic device which would enable a blind man to turn
any book into a talking book without the delays and difficulties attendant on con-
version into Braille or on recording by a volunteer reader.
We would then face the anomaly that a normal man who has purchased a book
in a bookstore or borrowed it from a library would be within his full rights in
reading this book anytime and anywhere he pleased; but, if I read the provisions
of the bill correctly, that a blind man using his prosthetic machine might well be
infringing a copyright:
(a) by causing his prosthetic machine to translate print into machine readable
form, whether or not transmission to a remote computer is required. If transmis-
sion were necessary, as is much more likely initially, then there might be further
infringement;
(b) by his exceeding the capricious 100-mile limit (Section 110 (2)B), which
would be probable since the necessary computers most likely could be provided
economically only at a limited number of regional centers.
(c) through his exercising his choice as an individual recipient "in activating
transmission from an information storage and retrieval system" or, as the bill
goes on, "*any similar device, machine, or process*" (Section 110 (2)D—my under-
line).

(8.17)

The 100-mile limit and the bar to individual choice in activating transmission have disappeared from the current version of the Copyright Revision Bill. However, the bill still contains provisions deserving wider public attention if the potential of computer and telecommunications technology for learning is not to be foreclosed. Section 110 (1) exempts "performance or display of a work by instructors or pupils in the course of face=to-face teaching activities of a non-profit educational institution, in a classroom or similar place devoted to instruction ..."(8.18). The potential of transmission of sound or moving picture materials to dormitory common rooms or student rooms in colleges and universities or to living rooms in "wired cities" should raise questions concerning the interpretation of face-to-face teaching activities and the definition of a place similar to a classroom.

In his study of copyright in books, photocopies and computer programs, Steven Breyer concluded that "the case for copyright in books rests not upon proven need, but rather upon uncertainties as to what would happen if protection were removed" (8.19). The murky and uncertain condition of property law throughout the realm spanned by the technologies of Figure 1 deserves deeper understanding and wider public debate. Meanwhile, much uncertainty in open university, publishing, cable distribution and information storage enterprises is attributed to a chaos in copyright which, in turn, hangs on uncertainties about the unfolding new information media and their impact on property rights in information. Our classical adversary proceedings, as Borchardt has noted (8.20), must be supplemented by mechanisms better capable of approximating the ideal market assumption of full understanding by all players.

IX. CONCLUSION

Our analysis shows that how technology can help learning is a far more complex question than most discussions of the subject have taken it to be. That the wages of simplistic thought are impotence or miscarriage has been amply documented in *Run, Computer, Run*.

The continuing importance, in the long run, of basic research on learning will be self-evident to anyone who shares our faith in rationality and the fruitfulness of scientific search for knowledge. No-significant-difference findings however, leave us with very little guidance from that quarter in the short term.

What emerges as crucial in the short term is the question of betting on custom-tailored or on standardized learning situations. Our analysis suggests that placing this bet first and picking a technology second is essential to achieving maximum return from investment in technology *in either case*. It further suggests that, with present knowledge, the justification of higher unit costs for custom-tailored over standardized processes, even under maximum return conditions, rests on intuitive preferences, hence that differences must be resolved through the political process, not by appeal to scientific truth.

Given the multiplicity of changing preferences, the no-significant-difference findings and the problems of transition from an idea to economies of scale in a learning market which peculiarly straddles the public and private sectors, a second crucial matter is lending coherence to trends now set mainly by blind self-interests groping about in a far from ideal market place. The channels for distribution of information must evolve on a scale large enough to be economically viable and either on a scale still small enough to permit diversity and competition, as in print technology, or in a common-carrier mode with effective regulation to assure divorce of control over conduit from control over content and to guarantee for all unfettered access to distribution at affordable prices.. Providing for effective storage facilities and, most important, for better knowledge of the whereabouts and modes of access to our great and growing wealth of information are corollary necessities.

Given unfettered and economical access to the means for distributing information, varied private and public patterns of mediating learning can continue to evolve with changing preferences under whatever guidance advancing knowledge of learning can provide. Otherwise, talk of technology helping learning in a democratic society will be academic in the most pejorative sense of the word.

NOTES

Section I

1.1 Yarmolinsky, p. 75; 1.2 Moynihan, p. 3; 1.3 U.S. Bureau of the Census, p. 105; 1.4 National Center for Educational Statistics, p. 13; 1.5 U.S. Bureau of the Census, p. 104; 1.6 Moses, p. 20; 1.7 Machlup, p. 362; 1.8 Bowen, p. 6; 1.9 President's Commission, p. 24; 1.10 Carpenter and Greenhill, p. 18; 1.11 Smith, P.D., pp. 164-167; pp. 236-240; 1.12 Saettler, Chapter 15; 1.13 Hilgard and Bower, p. 542; 1.14 Moynihan, p. 6; 1.15 Chu and Schramm, p. iv; 1.16 Klapper, p. x, 1.17 Saettler, pp. 333-334; 1.18 Smith, P.D., pp. 41-47; 1.19 Modern Language Journal. 1.20 Moynihan, pp. 6-7.

Section II

2.1 The following illustrates what may be missed by excessive concentration on abstract symbols and by neglect of the learning potential of familiar objects.

A useful tool for learning certain basic scientific principles and the impact of their applications on society could be had just by making the common toilet tank out of transparent material so that its internal mechanism will be visible. Working the handle to counteract the water pressure that pushes the ball valve against its seat on the outlet pipe for a tight seal, releases the water stored in the tank and triggers a feedback control mechanism that assures the refilling of the tank to a proper level. After the handle is released, thereby restoring the ball valve to its seat, the airtight float embodying Archimedes' principle, which fell as the water rushed out and thus opened a water inlet valve, rises again with the rising water level. This gradually closes the inlet valve and eventually shuts it off again entirely.

What better way to take the mystery out of cybernetics than this simple and useful example of the abstract, pervasive and functional principles of feedback control and homeostasis which is readily at hand throughout our homes, schools and places of work?

The S-shaped trap itself embodies the principles of the siphon and, together with the fixed amount of water available in the tank, assures the operation of the flush toilet independent of wide variations in water pressure. The water in the trap, replenished under control of the same float action that maintains the water level in the tank, seals the dwelling from the sewer and its lethal gases. The combined mechanism is an important factor both in the high urban population concentrations west of Calcutta and in the balance between cesspool and river sewage pollution problems.

The whole apparatus thus could provide a convenient vehicle for learning about the complex interactions among scientific, technological, ecological and social organization issues. Reyburn's neat little book provides excellent background for a lay introduction to the subject. In general, the prevalent architectural and industrial design canons that lead to opaque packaging rob most of our familiar objects of learning opportunities unsurpassable in immediacy and cogency by surrogates.

2.2 Aldis, pp. 22-23; 2.3 Oettinger, 1969, pp. 122-125.

Section III

3.1 Lord Crowther's Inaugural Address, in Open University, Prospectus 1972; 3.2 Ibid; See also Walsh for a general report on the Open University; 3.3 Ibid; p. 97, and Richard Hooper, personal communication; 3.4 Future Resources, p. 5; 3.5 Personal Communications: Dr. Arthur Chickering, Vice President for Academic Affairs and Mr. John McCormick, Asst. V.P. for Academic Affairs, Empire State College; 3.6 Personal Communications: Dr. Norman Somers, Director of Educational Experimentation, Chicago State University and Dr. William Moore, Director of Program Development, Northeastern Illinois University; 3.7 Boyer and Keller, p. 48; 3.8 Boyer interview; 3.9 Ibid.

Section IV

4.1 Thompson, 1970, p. 9; 4.2 Smith, A. D., p. 26; 4.3 Smith, A. D., p. 29; 4.4 Smith, A. D., pp. 72-77; 4.5 Walker, p. 29; 4.6 Hafen, p. 27; 4.7 Hafen, pp. 129-141; Rich, Chapter VI; 4.8 President's Commission, p. 23; 4.9 President's Commission, p. 138; 4.10 President's Commission, pp. 138-142; 4.11 Variety, 6/16/71, b; 4.12 Variety, 8/11/71, a; 4.13 Variety, 8/18/71, b; 4.14 Intelligible background analyses are given by Bagdikian, Borchardt and Goulden, See also the Sloan Commission report for both background and recommendations; 4.15 For background, see Borchardt, Committee on Telecommunications, Electronic Industries Association, General Learning, Gunn, Information Industry Association, Knox, President's Task Force, Thompson (1970) and Thompson (1971). 4.16 State Assembly, pp. 1-3; 4.17 Livingston, Roth, Teleprompter, p. 7, Variety, 2/3/71, and Electronic News, 10/25/71; 4.18 Knowles, pp. 122-130; 4.19 Burgess, p. 6; 4.20 ETV Newsletter, 7/26/71, p. 3; 4.21 Perlman, pp. 84-85; U.S. vs Southwestern Cable; 4.22 Variety, 8/11/71, b; 4.23 Jurgen; 4.24 Thompson, 1971; 4.25 Goulden, p. 61; 4.26 Electronic News, 5/31/71; 4.27 Traube; 4.28 ETV Newsletter 7/12/71, p. 2; Telecommunications Reports 6/21/71, pp. 30-32; Variety, 6/16/71, a; 4/29 Federal Communications Commission; L. L. Johnson; Park; 4.30 Bell Laboratories Record; 4.31 Telecommunications Reports, 6/21/71, pp. 30-32; 4.32 Goulden, p. 302, p. 320; 4.33 Federal Communications Commission, p. 31; 4.34 Telecommunications Reports, 2/5/70, pp. 21-23; 4.35 Gould, 8/7/70; Private Communication: Martin Sugar, Consultant to President, Comtel, Inc.; Variety, 10/14/70; Lydon, 10/8/71; 4.36 Telecommunications Reports, 7/19/71, pp. 34-35; 4.37 Taylor; 4.38 Evening Star; 4.39 Michie, 8/11/71; Variety, 12/23/70; 4.40 Variety, 8/18/71, a; Midrie, 10/13/71; 4.41 State Assembly, pp. 1-3; 4.42 Variety, 7/7/71, a;

Section V

5.1 Carter and Muir, pp. xxii-xxiii; 5.2 Ibid; 5.3 Taylor and Arlt, pp. 9-10; 5.4 Taylor and Arlt, p. 11; 5.5 Aldis, p. 22; 5.6 Taylor and Arlt, pp. 10-11; 5.7 Taylor and Arlt, p. 31; 5.8 Taylor and Arlt, p. 10; 5.9 Carter and Muir, p. xxvii; 5.10 Crowell Collier, p. 2; 5.11 Poulin, p. 358; 5.12 Komoski, p. 20; 5.13 Oettinger, 1971; 5.14 Crowell Collier, p. 3; 5.15 Atkinson and Wilson; Blum; Greenberger; Gruenberger; Holtzmann; Levien; Margolin and Misch; Martin and Norman; Mathison and Walker; President's Science Advisory Committee; Sackman and Nie; Taviss; Tickton; Westin and Zinn; 5.16 The Office; Business Week; 5.17 General Learning Corp., Vol. II, p. 90; 5.18 Committee on Telecommunications, p. 49; 5.19 Variety, 6/16/71, c;

5.20 Variety, 6/30/71; 5.21 U.S. Bureau of the Census, p. 486; 5.22 Variety, 2/17/71; 5.23 Oettinger, 1969, Chapter 1; 5.24 ETV Newsletter 6/28/71, pp. 1-2; 5.25 Greely; Kaufman; Variety 3/31/71

Section VI

6.1 U.S. Bureau of the Census, p. 132; U.S. Office of Education, p. 2; 6.2 Bobinski, pp. 4-6; 6.3 A. S. Johnson, p. 7; 6.4 A. S. Johnson, p. 4; 6.5 Bobinski, p. 108; 6.6 U.S. Bureau of the Census, pp. 132-133; 6.7 Council on Library Resources, p. 2; 6.8 See the publications by Committee on Scientific and Technical Communication and by Information Systems Panel and also their bibliographies; 6.9 Cuadra; Government Executive; 6.10 Holmes, p. 748; 6.11 National Instructional Television Center; 6.12 Tickton, Vol. I, p. 24; 6.13 For more extensive discussion see Carpenter and Greenhill; Chu and Schramm; and Murphy and Gross;

Section VII

7.1 Folger and Nam, p. 115; 7.2 Carter and Muir, p. xxii; 7.3 Chu and Schramm, pp. 162-168; 7.4 Altick p, 233; 7.5 Variety, 7/7/71, b; 7.6 Radical Software; 7.7 Kletter; 7.8 Brown; Lottman; Nimmer; Variety 6/2/71; Variety 6/16/71, d; Variety, 10/13/71; 7.9 Nimmer, pp. 1-2; 7.10 Lottman, pp. 27-31; 7.11 Altick, p. 1;

Section VIII

8.1 Parkus; 8.2 Variety 6/23/71, b; 7/28/71; 8.3 Telecommunications Reports 3/29/71; p. 23; 8.4 Variety 6/16/71, e; 8.5 Variety 6/23/71, a; 8.6 Variety 8/25/71; Federal Communications Commission; Lydon, 11/12/71; Gould 11/15/71; 8.7 Carter and Muir, p. xxiii; 8.8 Cuadra gives extensive description of these; 8.9 Cuadra; Government Executive; 8.10 Boulding, p. 12; see also Olsen; 8.11 Clapp, pp. 2-3; 8.12 Clapp, pp. 2-3; 8.13 Clapp, p. 24; 8.14 Clapp, p. 21; 8.15 Association of Research Libraries; 8.16 Hearings, p. 588; 8.17 Hearings, pp. 588-589; 8.18 Ninety Second Congress; 8.19 Breyer, p. 322; 8.20 Borchardt, Chapters IV and V.

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